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# Volume 7 Standalone Appendices

## Appendix 19 Caledonia OWF Digital Aerial Surveys

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OCEAN WINDS

# Volume 7 Appendix 19 Caledonia OWF Digital Aerial Surveys

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# Ocean Winds Caledonia Offshore Wind Farm Digital Aerial Surveys

## Ocean Winds UK Ltd

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# 1. Executive summary

Ocean Winds Ltd. (Ocean Winds) contracted APEM Ltd. (APEM) to undertake 24 monthly baseline digital aerial surveys of the proposed Caledonia Offshore Wind Farm (OWF), commencing May 2021 and ending April 2023. Caledonia OWF was previously known as NE4 Proposed Development Area (PDA). Caledonia OWF plus a 4 kilometres (km) buffer will be hereafter referred to as the Survey Area. Surveys were carried out using APEM's high-resolution digital still camera system to assess the abundance and distribution of birds and marine mammals in the Survey Area.

A dividing border between the north and south of Caledonia OWF was established by Ocean Winds, subsequently defining two subdivisions within the Survey Area, hereafter referred as Caledonia North and Caledonia South (Figure 1). Ocean Winds contracted APEM to analyse the data for the two subdivisions and associated buffers in addition to the Survey Area. Each subdivision has a 4 km buffer (Figure 1).

Images from 24 surveys carried out between May 2021 and April 2023 have been analysed by APEM, and the outputs of this analysis are the subject of this report. Raw counts, design-based unapportioned abundance and density estimates of all species, apportioned abundance and density estimates of specific species and availability-corrected abundance estimates of guillemot, razorbill, puffin and harbour porpoise are presented. Incidental observations recorded during the surveys are also presented as well as information on species distribution and flight direction. The key findings within the Caledonia OWF, Caledonia North and Caledonia South carried out between May 2021 and April 2023, expressed as raw counts, are summarised below.

- **Survey 1 – May 2021**

*Survey Area:* Auks were the most frequently recorded species group recorded (n=2,402), followed by small gulls (n=195). In addition, fulmars (n=91), gannets (n=14), terns (n=13), auks and/or shearwaters (n=10), unidentified bird species (n=8), marine mammals (n=8), unidentified gulls (n=2), large gulls (n=1), skuas (n=1) and shearwaters (n=1) were also recorded.

*Caledonia North Survey Area:* Auks were the most frequently recorded species group (n=786), followed by small gulls (n=81). In addition, fulmars (n=61), gannets (n=8), auk / shearwater (n=6), terns (n=3), marine mammals (n=3), large gull (n=1), and skua (n=1) were also recorded.

*Caledonia South Survey Area:* Auks were the most frequently recorded species group (n=1,890), followed by small gulls (n=139). In addition, fulmars (n=46), terns (n=10), gannets (n=8), unidentified bird species (n=8), marine mammals (n=6), auk / shearwater species (n=5), unidentified gull (n=2) and shearwater (n=1) were also recorded.

- **Survey 2 – June 2021**

*Survey Area:* Auks were the most frequently recorded species group recorded (n=1,703), followed by small gulls (n=358). In addition, gannets (n=114), fulmars (n=105), shearwaters (n=15), auks and/or shearwaters (n=14), marine mammals (n=7), unidentified bird species (n=4), large gulls (n=2), skuas (n=1) and divers (n=1) were also recorded.

*Caledonia North Survey Area:* Auks were the most frequently recorded species group (n=542), followed by small gulls (n=80). In addition, fulmars (n=52), gannets (n=51), marine mammals (n=5), skua (n=2), unidentified bird species (n=2), large gull (n=1), shearwater (n=1) and auk / shearwater (n=1) were also recorded.

*Caledonia South Survey Area:* Auks were the most frequently recorded species group (n=1,389), followed by small gulls (n=311). In addition, gannets (n=79), fulmars (n=74), shearwaters (n=15), auk and/or shearwaters (n=14), marine mammal (n=4), unidentified bird species (n=3), skuas (n=2), large gull (n=1), and divers (n=1) were also recorded.

- **Survey 3 – July 2021**

*Survey Area:* Auks were the most frequently recorded species group (n=3,211), followed by small gulls (n=1,083). In addition, fulmars (n=790), gannets (n=34), large gulls (n=22), auks and/or shearwaters (n=13), marine mammals (n=13), skuas (n=10), shearwaters (n=3), terns (n=2), unidentified bird species (n=2) and unidentified gulls (n=1) were also recorded.

*Caledonia North Survey Area:* Auks were the most frequently recorded species group (n=1,200), followed by small gulls (n=513). In addition, fulmars (n=215), large gulls (n=22), gannets (n=9), auk / shearwaters (n=7), marine mammals (n=6), skuas (n=5), terns (n=2), unidentified gulls (n=1), shearwaters (n=1) and unidentified bird species (n=1) were also recorded.

*Caledonia South Survey Area:* Auks were the most frequently recorded species group (n=2,602), followed by small gulls (n=857). In addition, fulmars (n=673), gannets (n=29), auk / shearwater (n=10), marine mammals (n=9), skuas (n=5), shearwaters (n=2), unidentified bird species (n=2), and large gull (n=1) were also recorded.

- **Survey 4 – August 2021**

*Survey Area:* Auks were the most frequently recorded species group (n=1,329), followed by small gulls (n=294). In addition, fulmars (n=285), gannets (n=71), skuas (n=6), terns (n=5), large gulls (n=3), unidentified bird species (n=3), unidentified gulls (n=2) and marine mammals (n=1) were also recorded.

*Caledonia North Survey Area:* Auks were the most frequently recorded species group (n=565), followed by fulmars (n=179). In addition, small gulls (n=75), gannets (n=26), skuas (n=6), terns (n=5), large gulls (n=3), unidentified bird species (n=2), unidentified gull (n=1), and marine mammal (n=1) were also recorded.

*Caledonia South Survey Area:* Auks were the most frequently recorded species group (n=987), followed by small gulls (n=247). In addition, fulmars (n=178), gannets (n=57), terns (n=5), skuas (n=2), unidentified gulls (n=1) and unidentified bird species (n=1) were also recorded.

- **Survey 5 – September 2021**

*Survey Area:* Auks were the most frequently recorded species group (n=1,101), followed by small gulls (n=166). In addition, fulmars (n=113), gannets (n=101), large gulls (n=81), marine mammals (n=10), unidentified bird species (n=3), shearwaters (n=1) and skuas (n=1) were also recorded.

*Caledonia North Survey Area:* Auks were the most frequently recorded species group (n=225), followed by large gulls (n=81). In addition, gannets (n=62), fulmars (n=52), small gulls (n=17), marine mammals (n=7), and unidentified bird species (n=3) were also recorded.

*Caledonia South Survey Area:* Auks were the most frequently recorded species group (n=987), followed by small gulls (n=154). In addition, fulmars (n=93), gannets (n=47), large gulls (n=14), marine mammals (n=5), shearwaters (n=1), skuas (n=1) and unidentified bird species (n=1) were also recorded.

- **Survey 6 – October 2021**

*Survey Area:* Auks were the most frequently recorded species group (n=411), followed by gannets (n=125). In addition, small gulls (n=85), large gulls (n=58), marine mammals (n=24), fulmars (n=12) and unidentified bird species (n=1) were also recorded.

*Caledonia North Survey Area:* Auks were the most frequently recorded species group (n=119), followed by gannets (n=89). In addition, large gulls (n=58), small gulls (n=52), marine mammals (n=22), and fulmars (n=1) were also recorded.

*Caledonia South Survey Area:* Auks were the most frequently recorded species group (n=366), followed by gannets (n=82). In addition, small gulls (n=46), marine mammals (n=19), fulmars (n=11), large gulls (n=2) and unidentified bird species (n=1) were also recorded.

- **Survey 7 – November 2021**

*Survey Area:* Auks were the most frequently recorded species group (n=454), followed by large gulls (n=195). In addition, fulmars (n=180), small gulls (n=144), gannets (n=16), marine mammals (n=16) and divers (n=1) were also recorded.

*Caledonia North Survey Area:* Auks were the most frequently recorded species group (n=199), followed by small gulls (n=139). In addition, large gulls (n=101), fulmar (n=45), marine mammals (n=13) and gannets (n=6) were also recorded.

*Caledonia South Survey Area:* Auks were the most frequently recorded species group (n=354), followed by fulmars (n=136). In addition, large gulls (n=119), small gulls (n=61), gannets (n=14), marine mammals (n=13) and divers (n=1) were also recorded.

- **Survey 8 – December 2021**

*Survey Area:* Auks were the most frequently recorded species group (n=232), followed by fulmars (n=194). In addition, small gulls (n=27), large gulls (n=18), marine mammals (n=11), unidentified bird species (n=6), and gannets (n=4) were also recorded.

*Caledonia North Survey Area:* Auks were the most frequently recorded species group (n=96), followed by fulmars (n=87). In addition, small gulls (n=18), large gulls (n=11), unidentified bird species (n=3), gannets (n=2), and marine mammals (n=1) were also recorded.

*Caledonia South Survey Area:* Auks were the most frequently recorded species group (n=169), followed by fulmars (n=118). In addition, small gulls (n=17), marine mammals (n=11), large gulls (n=9), unidentified bird species (n=3), and gannets (n=2) were also recorded.

- **Survey 9 – January 2022**

*Survey Area:* Auks were the most frequently recorded species group (n=132), followed by fulmars (n=55). In addition, large gulls (n=50), small gulls (n=8), marine mammals (n=7), unidentified bird species (n=5), gannets (n=2) and sharks (n=1) were also recorded.

*Caledonia North Survey Area:* Auks were the most frequently recorded species group (n=62), followed by large gulls (n=38). In addition, fulmars (n=37), small gulls (n=7), unidentified bird species (n=2), and marine mammals (n=1) were also recorded.

*Caledonia South Survey Area:* Auks were the most frequently recorded species group (n=99), followed by fulmars (n=31). In addition, large gulls (n=27), marine mammals (n=6), small gulls (n=4), unidentified bird species (n=3), gannets (n=2) and sharks (n=1) were also recorded.

- **Survey 10 – February 2022**

*Survey Area:* Auks were the most frequently recorded species group (n=419) followed by fulmars (n=80). In addition, large gulls (n=50), small gulls (n=29), marine mammals (n=13), gannets (n=5), wildfowl (n=2), unidentified gulls (n=1) and unidentified bird species (n=1) were also recorded.

*Caledonia North Survey Area:* Auks were the most frequently recorded species group (n=198) followed by fulmars (n=37). In addition, large gulls (n=24), small gulls (n=21), marine mammals (n=13), unidentified gulls (n=1) and unidentified bird species (n=1) were also recorded.

*Caledonia South Survey Area:* Auks were the most frequently recorded species group (n=265) followed by fulmars (n=56). In addition, large gulls (n=37), small gulls (n=11), marine mammals (n=10), gannets (n=5), and wildfowl (n=2) were also recorded.

- **Survey 11 – March 2022**

*Survey Area:* Auks were the most frequently recorded species group (n=203) followed by small gulls (n=42). In addition, fulmars (n=28), marine mammals (n=11), large gulls (n=4), gannets (n=1) unidentified bird species (n=1) were also recorded.

*Caledonia North Survey Area:* Auks were the most frequently recorded species group (n=83) followed by small gulls (n=35). In addition, fulmars (n=22), marine mammals (n=5), large gulls (n=4), and unidentified bird species (n=1) were also recorded.

*Caledonia South Survey Area:* Auks were the most frequently recorded species group (n=161) followed by small gulls (n=15). In addition, fulmars (n=10), marine mammals (n=8), large gulls (n=2) and gannets (n=1) were also recorded.

- **Survey 12 – April 2022**

*Survey Area:* Auks were the most frequently recorded species group (n=861) followed by small gulls (n=100). In addition, fulmars (n=70), gannets (n=12), marine mammals (n=6), auks and/or shearwaters (n=2) and unidentified bird species (n=2) were also recorded.

*Caledonia North Survey Area:* Auks were the most frequently recorded species group (n=381) followed by small gulls (n=35). In addition, fulmars (n=24), marine mammals (n=5), gannets (n=4), and auks and/or shearwaters (n=2) were also recorded.

*Caledonia South Survey Area:* Auks were the most frequently recorded species group (n=651) followed by small gulls (n=80). In addition, fulmars (n=56), gannets (n=10), marine mammals (n=3) and unidentified bird species (n=2) were also recorded.

- **Survey 13 – May 2022**

*Survey Area:* Auks were the most frequently recorded species group (n=4,074) followed by small gulls (n=678). In addition, fulmars (n=54), gannets (n=22), marine mammals (n=14), auks and/or shearwaters (n=9), shearwaters (n=9), unidentified bird species (n=7), terns (n=6) and large gull (n=1) were also recorded.

*Caledonia North Survey Area:* Auks were the most frequently recorded species group (n=2,936) followed by small gulls (n=533). In addition, fulmars (n=32), gannets (n=7), terns (n=6), auk / shearwaters (n=6), marine mammals (n=4), shearwaters (n=3), unidentified bird species (n=3), and large gull (n=1) were also recorded.

*Caledonia South Survey Area:* Auks were the most frequently recorded species group (n=2,001) followed by small gulls (n=236). In addition, fulmars (n=34), gannets (n=17), marine mammals (n=11), shearwaters (n=8), auk / shearwaters (n=3), unidentified bird species (n=3) and terns (n=2) were also recorded.

- **Survey 14 – June 2022**

*Survey Area:* Auks were the most frequently recorded species group (n=2,417) followed by small gulls (n=813). In addition, gannets (n=267), fulmars (n=204), marine mammals (n=33), auks and/or shearwaters (n=5), unidentified bird species (n=5), large gulls (n=3), and wader species (n=1) were also recorded.

*Caledonia North Survey Area:* Auks were the most frequently recorded species group (n=1,195) followed by small gulls (n=300). In addition, fulmars (n=130), gannets (n=78), marine mammals (n=14), auk / shearwaters (n=4), large gulls (n=3), unidentified bird species (n=3) and wader species (n=1) were also recorded.

*Caledonia South Survey Area:* Auks were the most frequently recorded species group (n=1,644) followed by small gulls (n=680). In addition, gannets (n=228), fulmars (n=109), marine mammals (n=22), auk / shearwaters (n=4), unidentified bird species (n=4) and wader species (n=1) were also recorded.

- **Survey 15 – July 2022**

*Survey Area:* Auks were the most frequently recorded species group (n=3,073) followed by fulmars (n=1,634). In addition, small gulls (n=920), gannets (n=110), large gulls (n=47), marine mammals (n=22), unidentified bird species (n=13) and skuas (n=2) were also recorded.

*Caledonia North Survey Area:* Auks were the most frequently recorded species group (n=865) followed by fulmars (n=407). In addition, small gulls (n=316), gannets (n=50), marine mammals (n=14), large gulls (n=12), unidentified bird species (n=9), and skuas (n=2) were also recorded.

*Caledonia South Survey Area:* Auks were the most frequently recorded species group (n=2,655) followed by fulmars (n=1,442). In addition, small gulls (n=860), gannets (n=97), large gulls (n=46), marine mammals (n=17), unidentified bird species (n=6), and skuas (n=1) were also recorded.

- **Survey 16 – August 2022**

*Survey Area:* Auks were the most frequently recorded species group (n=401) followed by small gulls (n=146). In addition, fulmars (n=115), terns (n=14), gannets (n=12), marine mammals (n=12), unidentified bird species (n=6), gulls (n=3), skuas (n=2) and shearwater (n=1) were also recorded.

*Caledonia North Survey Area:* Auks were the most frequently recorded species group (n=113), followed by small gulls (n=75). In addition, fulmars (n=63), gannets (n=8), marine mammals (n=4), unidentified bird species (n=3), unidentified gulls (n=1), terns (n=1) and skuas (n=1) were also recorded.

*Caledonia South Survey Area:* Auks were the most frequently recorded species group (n=340), followed by small gulls (n=94). In addition, fulmars (n=76), terns (n=13), marine mammals (n=11), gannets (n=10), unidentified bird species (n=4), skuas (n=2), unidentified gulls (n=2), and shearwaters (n=1) were also recorded.

- **Survey 17 – September 2022**

*Survey Area:* Auks were the most frequently recorded species group (n=3,325) followed by gannets (n=105). In addition, auks and/or shearwaters (n=74), small gulls (n=50), fulmars (n=47), marine mammals (n=29), large gulls (n=12), shearwaters (n=2) and unidentified bird species (n=1) were also recorded.

*Caledonia North Survey Area:* Auks were the most frequently recorded species group (n=895) followed by gannets (n=46). In addition, small gulls (n=22), marine mammals (n=20), fulmars (n=19), large gulls (n=10), auk / shearwaters (n=1) and unidentified bird species (n=1) were also recorded.

*Caledonia South Survey Area:* Auks were the most frequently recorded species group (n=2,707) followed by gannets (n=87). In addition, auks and/or shearwaters (n=73), fulmars (n=38), small gulls (n=35), marine mammals (n=12), large gulls (n=4), and shearwaters (n=2) were also recorded.

- **Survey 18 – October 2022**

*Survey Area:* Passerine species were the most frequently recorded species group (n=367) followed by auks (n=214). In addition, marine mammals (n=54), gannets (n=47), large gulls (n=42), small gulls (n=32), fulmars (n=4), unidentified bird species (n=2) and divers (n=1) were also recorded.

*Caledonia North Survey Area:* Passerine species were the most frequently recorded species group (n=271) followed by auks (n=89). In addition, large gulls (n=24), marine mammals (n=13), gannets (n=10), small gulls (n=4), divers (n=1) and unidentified bird species (n=1) were also recorded.

*Caledonia South Survey Area:* Passerine species were the most frequently recorded species group (n=225) followed by auks (n=157). In addition, gannets (n=42), marine mammals (n=42), small gulls (n=31), large gulls (n=26), fulmar (n=4), divers (n=1), and unidentified bird species (n=1) were also recorded.

- **Survey 19 – November 2022**

*Survey Area:* Fulmars were the most frequently recorded species group (n=252) followed by auks (n=63). In addition, large gulls (n=23), small gulls (n=17), marine mammals (n=6), gannets (n=2), fulmar and/or gull species (n=2), sharks (n=1) and unidentified bird species (n=1) were also recorded.

*Caledonia North Survey Area:* Fulmars were the most frequently recorded species group (n=167) followed by auks (n=35). In addition, small gulls (n=13), large gulls (n=13), marine mammals (n=4), fulmar and/or gull species (n=1), and unidentified bird species (n=1) were also recorded.

*Caledonia South Survey Area:* Fulmars were the most frequently recorded species group (n=140) followed by auks (n=53). In addition, large gulls (n=18), small gulls (n=13), marine mammals (n=4), gannets (n=2), fulmar and/or gull species (n=1), and sharks (n=1) were also recorded.

- **Survey 20 – December 2022**

*Survey Area:* Auks were the most frequently recorded species group (n=118) followed by fulmars (n=87). In addition, large gulls (n=30), small gulls (n=10), gannets (n=5), marine mammals (n=5), gulls (n=2) and unidentified bird species (n=1) were also recorded.

*Caledonia North Survey Area:* Auks were the most frequently recorded species group (n=68) followed by fulmars (n=60). In addition, large gulls (n=21), small gulls (n=7), gannets (n=4), marine mammals (n=2), unidentified gulls (n=1), and unidentified bird species (n=1) were also recorded.

*Caledonia South Survey Area:* Auks were the most frequently recorded species group (n=75) followed by fulmars (n=52). In addition, large gulls (n=17), small gulls (n=6), gannets (n=4), marine mammals (n=3), and unidentified gulls (n=1) were also recorded.

- **Survey 21 – January 2023**

*Survey Area:* Auks were the most frequently recorded species group (n=179) followed by fulmars (n=53). In addition, large gulls (n=33), marine mammals (n=10), small gulls (n=5), gannets (n=3) and wildfowl (n=1) were also recorded.

*Caledonia North Survey Area:* Auks were the most frequently recorded species group (n=84) followed by fulmars (n=26). In addition, large gulls (n=22), marine mammals (n=6), small gulls (n=4), gannets (n=1) and wildfowl (n=1) were also recorded.

*Caledonia South Survey Area:* Auks were the most frequently recorded species group (n=132) followed by fulmars (n=36). In addition, large gulls (n=18), marine mammals (n=5), gannets (n=3), small gulls (n=2), and wildfowl (n=1) were also recorded.

- **Survey 22 – February 2023**

*Survey Area:* Auks were the most frequently recorded species group (n=559) followed by fulmars (n=37). In addition, small gulls (n=33), marine mammals (n=18), large gulls (n=17), and gannets (n=8) were also recorded.

*Caledonia North Survey Area:* Auks were the most frequently recorded species group (n=246) followed by fulmars (n=20). In addition, small gulls (n=15), large gulls (n=11), marine mammals (n=7) and gannets (n=6) were also recorded.

*Caledonia South Survey Area:* Auks were the most frequently recorded species group (n=418) followed by fulmars (n=22). In addition, small gulls (n=21), marine mammals (n=12), large gulls (n=11), and gannets (n=3) were also recorded.

- **Survey 23 – March 2023**

*Survey Area:* Auks were the most frequently recorded species group (n=650) followed by fulmars (n=96). In addition, small gulls (n=16), marine mammals (n=13), large gulls (n=6), auks and/or shearwaters (n=4), fulmar and/or gulls (n=1), and gannets (n=1) were also recorded.

*Caledonia North Survey Area:* Auks were the most frequently recorded species group (n=409) followed by fulmars (n=54). In addition, small gulls (n=8), marine mammals (n=6), large gulls (n=4), auks and/or shearwaters (n=2), and fulmar / gull species (n=1) were also recorded.

*Caledonia South Survey Area:* Auks were the most frequently recorded species group (n=455) followed by fulmars (n=54). In addition, small gulls (n=13), marine mammals (n=10), large gulls (n=3), auks and/or shearwaters (n=2), gannets (n=1), and fulmar / gull species (n=1) were also recorded.

- **Survey 24 – April 2023**

*Survey Area:* Auks were the most frequently recorded species group (n=640) followed by small gulls (n=129). In addition, fulmars (n=39), gannets (n=15), marine mammals (n=7), large gulls (n=1), and auks and/or shearwaters (n=1) were also recorded.

*Caledonia North Survey Area:* Auks were the most frequently recorded species group (n=159) followed by fulmars (n=27). In addition, small gulls (n=9) and marine mammals (n=4) were also recorded.

*Caledonia South Survey Area:* Auks were the most frequently recorded species group (n=560) followed by small gulls (n=123). In addition, gannets (n=15), fulmars (n=15), marine mammals (n=4), large gulls (n=1), and auks and/or shearwaters (n=1) were also recorded.

# 2. Introduction

## 2.1 Background

APEM has been contracted by Ocean Winds for the supply of a programme of 24 monthly digital aerial surveys, the main purpose of which is to provide baseline information on the distribution and abundance of seabirds and marine mammals within and around Caledonia OWF. Ocean Winds and APEM engaged with NatureScot and Marine Scotland Science (now Marine Directorate) on 22nd October 2020 to discuss the data collection and assessment methods. Method feedback was provided on 6th November 2021 and final feedback was provided on 16th December 2021.

Caledonia OWF (Figure 1) is a site within the Final Sectoral Marine Plan for Offshore Wind Energy. The water depth across Caledonia OWF is predominantly shallow (<60 metres [m]) throughout, with small areas of deeper water (60-100 m) in the south of the Plan Option (PO).

A desk study was undertaken to inform on the potential seabird species likely to be present within Caledonia OWF. The Sectoral Marine Plan Strategic Environmental Assessment (SEA) and Habitat Regulations Appraisal (HRA) identified Caledonia OWF as likely to be important as a foraging area for seabirds, in particular black-legged kittiwake, from multiple Special Protection Areas (SPAs).

## 2.2 Aim of the report

The report presents information on marine birds, mammals and other megafauna, derived from 24 consecutive months of digital aerial surveys (May 2021 to April 2023 inclusive) of a Survey Area consisting of Caledonia OWF plus a 4 km buffer (collectively referred to as the Survey Area) and its subdivisions, Caledonia North and Caledonia South, plus their respective 4 km buffer. The information that is presented within this report and its appendices includes the following:

- Summary of surveys
- Health and safety summary
- Unapportioned abundance and density estimate for all bird, marine mammal and shark species recorded per month within the Survey Area and its subdivisions, apportioned abundance and density estimates of specific species, and apportioned and availability-corrected abundance and density estimates for auk species and harbour porpoises
- Bird flight direction
- Spatial distribution maps of birds and marine mammals.

The aim of this report is to provide information on the 24 monthly site-specific baseline surveys, which will inform the offshore ornithology and marine mammal Environmental Impact Assessment (EIA) and HRA. The report has been prepared in advance of the final assessment to provide stakeholders with an early sight of the ornithology baseline derived from the digital aerial surveys. Whilst every care has been taken during the preparation and presentation of the baseline data included within this report, it should not be regarded as final. Whilst it is not expected to be required, any substantive changes that may be required between this report and the final assessment will be highlighted within the assessment.

## 2.3 Site description

Caledonia OWF is located off northeast Scotland, approximately 23.4 kilometres (km) south-east of the Wick coast at its closest point (Figure 1) and covers an area of approximately 427 kilometres squared ($km^2$). The Survey area, Caledonia OWF plus a 4 km buffer, covers an area of approximatively 884 $km^2$. This was the standard Survey Area for all months.

Caledonia OWF was subdivided in two smaller areas, Caledonia North and Caledonia South (Figure 1). Caledonia North Survey Area includes Caledonia North plus a 4 km buffer (of which some of the buffer overlaps Caledonia South) and covers an area of approximatively 557 $km^2$ while Caledonia South Survey Area includes Caledonia South plus a 4 km buffer (of which some of the buffer overlaps Caledonia North) and covers an area of approximatively 534 $km^2$ (Figure 1). Information regarding the transect lines included in the reporting regions of Caledonia OWF, Caledonia North and Caledonia South and their 2 km and 4 km buffers is shown in Table 1.

**Table 1 Number of transects, survey line minimum / maximum lengths and total lengths of all survey lines in each reporting region within the Survey Area.**

| Region | No. transects | Minimum transect length (km) | Maximum transect length (km) | Total length of transects (km) |
|---|---|---|---|---|
| **Caledonia OWF** | 9 | 4.52 | 30.68 | 163.39 |
| **Caledonia OWF plus 2 km buffer** | 11 | 6.06 | 35.59 | 246.14 |
| **Survey Area** | 13 | 5.46 | 39.70 | 338.25 |
| **Caledonia North** | 7 | 3.07 | 18.13 | 83.48 |
| **Caledonia North plus 2 km buffer** | 9 | 4.42 | 24.25 | 141.91 |
| **Caledonia North Survey Area** | 11 | 3.40 | 28.83 | 211.71 |
| **Caledonia South** | 8 | 4.61 | 12.55 | 80.39 |
| **Caledonia South plus 2 km buffer** | 10 | 6.11 | 16.67 | 139.66 |
| **Caledonia South Survey Area** | 12 | 5.46 | 20.87 | 205.95 |

## 2.4 Bird and marine mammal names

Throughout this report the bird species names used are those that are in common use among British ornithologists, and this corresponds to the "British (English) vernacular name 2012" column of the list of English and scientific names prepared by the British Ornithologist's Union (BOU, 2022).

Scientific names and taxonomy of birds and marine fauna are provided in Appendix 1 – Scientific Names and Taxonomy.

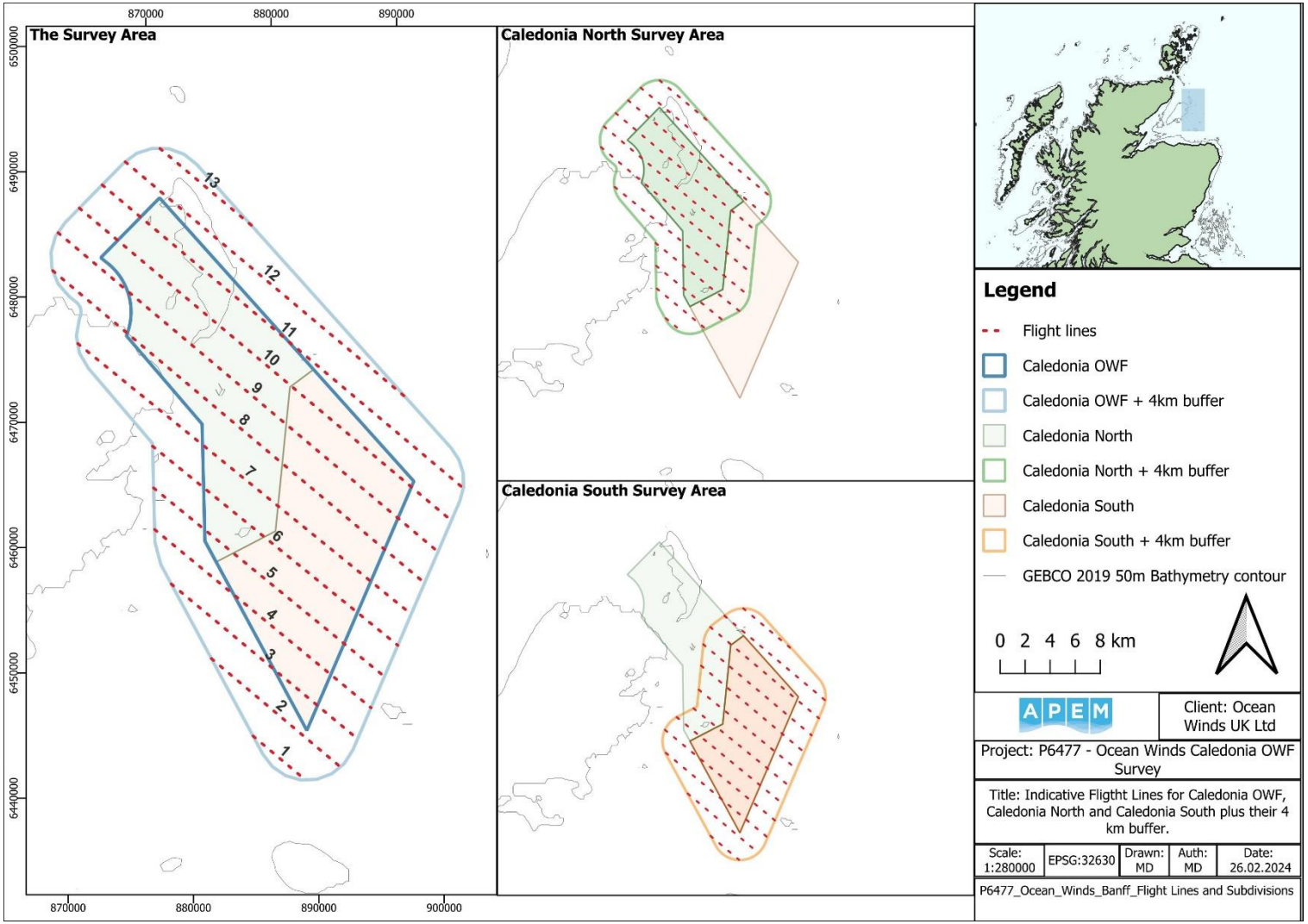



**Figure 1** **Caledonia OWF, Caledonia North and Caledonia South plus their 4 km buffer with indicative flight lines**

# 3. Survey and analysis methodologies

## 3.1 Summary of digital aerial surveys

A programme of 24 digital aerial surveys took place on a monthly basis between May 2021 and April 2023 inclusive.

Surveys were conducted using APEM's bespoke camera system, termed "Shearwater IV", customised by in-house specialists for surveying the offshore environment. The camera system is integrated with custom flight planning software that allows each survey transect to be accurately mapped out before the aircraft leaves the ground. Each image capture node is precisely defined, allowing the system to fire the camera exposures at exactly the right location. This ensures that each survey is flown with the same orientation and the camera is triggered at the same position within set tolerances. APEM's flight planning software enables tolerances along survey lines to be set, meaning the camera system would automatically abort data capture should the aircraft drift away from the planned flight line. APEM's on-board camera technician continually monitored the imagery as it was collected to ensure the data collected was fit for purpose. The camera technician would make the decision to cease data collection should the conditions become unsuitable for surveying and/or data collection. Subsequently, the survey would then be resumed at the next earliest opportunity.

The digital aerial surveys captured images at 1.5 cm ground sampling distance (GSD) along 13 transect lines spaced approximately 2.6 km apart within Survey Area (Figure 1).

Imagery was captured in raw format and post-processed to ensure optimal quality for the subsequent stage of image analysis, to extract information on marine fauna or other notable occurrences. When a survey was completed, data were checked to ensure the number of lines and the number of images collected was correct, and that the quality of the imagery was acceptable. Once the image analysis was completed, further QA processes took place (see Section 0).

No health or safety issues were reported during each of the surveys. The dates, number of flights needed to survey all transects (due to weather or technical issue), on task start and end times, are provided for each digital aerial survey in Table 2 with the corresponding weather conditions provided in Table 3.

**Table 2 Survey date, flight number and start / end time (Coordinated Universal Time) of each survey flight during May 2021 to April 2023 survey period**

| Survey No. | Date | Flight Number | UTC Start Time (HH:MM) | UTC End Time (HH:MM) |
|---|---|---|---|---|
| **1**[1] | 15-May-21 | 1 | 11:55 | 14:00 |
| **2**[1] | 10-Jun-21 | 1 | 15:56 | 18:11 |
| **3**[1] | 2-Jul-21 | 1 | 09:21 | 11:18 |
| **4**[1] | 1-Aug-21 | 1 | 17:41 | 19:48 |
| **5**[1] | 14-Sep-21[2] | 1 | 09:43 | 11:50 |
| **6**[1] | 4-Oct-21 | 1 | 08:50 | 10:52 |
| **7** | 15-Nov-21 | 1 | 10:34 | 12:38 |
| **8** | 6-Dec-21 | 2[3] | 13:04 | 14:21 |
| **9** | 9-Jan-22 | 1 | 10:22 | 12:19 |
| **10** | 13-Feb-22 | 1 | 11:16 | 13:18 |
| **11** | 2-Mar-22 | 1 | 09:34 | 11:36 |
| **12**[1] | 26-Apr-22 | 1 | 09:36 | 12:37 |
| **13**[1] | 14-May-22 | 1 | 10:41 | 12:40 |
| **14**[1] | 4-June-22 | 1 | 14:02 | 16:17 |
| **15**[1] | 5-July-22 | 1 | 15:57 | 18:05 |
| **16**[1] | 10-August-22 | 1 | 08:46 | 11:58 |
| **17**[1] | 11-Sep-22 | 1 | 09:01 | 11:02 |

| Survey No. | Date | Flight Number | UTC Start Time (HH:MM) | UTC End Time (HH:MM) |
|---|---|---|---|---|
| **18**[1] | 14-Oct-22 | 1 | 09:22 | 11:22 |
| **19** | 25-Nov-22 | 1 | 09:37 | 11:35 |
| **20** | 17-Dec-22 | 1 | 10:37 | 12:42 |
| **21** | 9-Jan-23[4] | 2 | 09:40 | 11:54 |
| **22** | 13-Feb-23 | 1 | 11:49 | 14:30 |
| **23** | 10-Mar-23 | 1 | 14:41 | 16:50 |
| **24**[1] | 04-Apr-23 | 1 | 08:57 | 10:57 |

[1] UTC time is identical to GMT (i.e. surveys 7 to 11), but for surveys undertaken during BST (i.e. surveys 1 to 6, and 12), differs from UK time by -1 hour.

[2] Survey 13th of September 2021 aborted due to aircraft issue and re-flown on the 14th of September.

[3] Survey 6th of December 2021 was flown by two planes. The start time correspond to the time the first plane started recording and the end time correspond to the time the second plane finished recording.

[4] Survey 7th January 2023 aborted due to rain and re-flown on the 9thJanuary.

**Table 3 Weather conditions recorded during each survey flight during the May 2021 to April 2023 survey period**

| Survey No. | Date | Douglas Sea State[1] | Turbidity[2] | Wind Speed (knots) / direction | Cloud Cover (%)[3] | Visibility (km) | Air Temp (°C) |
|---|---|---|---|---|---|---|---|
| **1** | 15-May-21 | 1 | 1 | 3-13 / N-NNE | 100 | 10+ | 5 |
| **2** | 10-Jun-21 | 2 | 0 | 21-29 / W | 100 | 10+ | 18 |
| **3** | 2-Jul-21 | 1 | 1 | 5 / N | 90 | 10+ | 10 |
| **4** | 1-Aug-21 | 2 | 0 | 15-18 / NNW | 99 | 20+ | 8 |
| **5** | 14-Sep-21 | 3 | 2 | 5-10 / SSE | 30-45 | 10+ | 12 |
| **6** | 4-Oct-21 | 2-3 | 1 | 14-22 / SW | 20-30 | 10+ | 9 |
| **7** | 15-Nov-21 | 1 | 1 | 8-15 / W | 20 | 10+ | 7-8 |
| **8** | 6-Dec-21 | 2 | 1-2 | 12-20 / S | 100 | 30+ | 3 |
| **9** | 9-Jan-22 | 0 | 0 | 3-9 / S-W | 5 | 30+ | 4 |
| **10** | 13-Feb-22 | 2 | 1 | 6-8 / W-SW | 60-90 | 10+ | 5 |
| **11** | 2-Mar-22 | 2-4 | 1 | 24-29 / SE | 10-40 | 10+ | 2-3 |
| **12** | 26-Apr-22 | 1 | 2 | 9-20 / NE-NNE | 75 | 10+ | 4 |
| **13** | 14-May-22 | 2 | 2 | 18 / W | 100 | 10+ | 9 |
| **14** | 4-June-22 | 2 | 2 | 6-10 / N | 0 | 10+ | 13 |
| **15** | 5-July-22 | 3 | 3 | 3-7 / W- SE | 35 | 20+ | 11 |
| **16** | 10-Aug-22 | 0.5 – 1.5 | 0.5 - 1 | 17 – 31 / SW | 0-100 | 40+ | 18 |
| **17** | 11-Sep-22 | 2 - 3 | 0 | 13 – 18 / S | 20 - 60 | 10+ | 13 |
| **18** | 14-Oct-22 | 3 | 2 | 18 / W - SW | 10 | 10+ | 8 |
| **19** | 25-Nov-22 | 3 | 2 | 23 – 34 / S | 10 - 80 | 20 - 30 | 7 - 8 |
| **20** | 17-Dec-22 | 3 | 2 | 22 – 29 / SW - W | 80 - 95 | 20 | 3 |
| **21** | 9-Jan-23 | 1 | 1 | 19 / W | 20 | 10+ | 5 |
| **22** | 13-Feb-23 | 1 | 1 | 7 – 13 / S - W | 10 | 10+ | 6 - 7 |
| **23** | 10-Mar-23 | 1 - 2 | 0 | 5 – 26 / SW -W | 50 - 70 | 10+ | 0 |
| **24** | 4-Apr-23 | 1 - 2 | 0 | 15 -17 / SW | 80 -100 | 10+ | 6 -7 |

[1] 0 = Calm (Glassy), 1 = Calm (Rippled), 2 = Smooth, 3 = Slightly Moderate, 4 = Moderate

[2] 0 = Clear, 1 = Slightly Turbid, 2 = Moderately Turbid, 3 = Highly Turbid

[3] 0 = Clear, 1-10 = Few, 11-50 = Scattered, 51-95 = Broken, 96-100 = Overcast

Weather conditions during all surveys were conducive to collecting and analysing imagery for the purpose of providing data on the identification, distribution and abundance of bird species and marine fauna within the Survey Area. Favourable conditions for surveying are defined as a cloud base of at least 1,300 ft, visibility of >5 km, wind speed of <30 knots, and sea state of 4 (moderate) or less. For safety reasons, no surveying took place in icing conditions.

Measures were taken to minimise glint and glare, such as avoiding surveying when the sun angle has the greatest potential to impact image quality. Furthermore, additional imagery was collected through the survey, providing an alternative set of images for analysis to ensure that sufficient coverage is achieved in the case that imagery was affected strongly by glint or glare. The number of image nodes clipped to the Survey Area, coverage collected per survey within the Survey Area, and the analysed coverage per Site and Site plus 4 km buffer are presented in Table 4.

**Table 4 Number of images and survey coverage collected for each monthly survey across the Survey Area, and analysed coverage per region during the May 2021 to April 2023 survey period**

| Survey No. | No. image nodes | Survey coverage (%) | Coverage analysed (%) | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | Caledonia OWF | Survey Area | Caledonia North | Caledonia North Survey Area | Caledonia South | Caledonia South Survey Area |
| **1** | 2385 | 25.49 | 17.14 | 17.39 | 17.15 | 17.07 | 17.16 | 17.22 |
| **2** | 2384 | 25.48 | 17.02 | 17.23 | 16.92 | 16.89 | 17.18 | 17.19 |
| **3** | 2323 | 24.85 | 16.94 | 17.25 | 16.89 | 16.50 | 17.04 | 16.64 |
| **4** | 2383 | 25.47 | 17.26 | 17.51 | 17.26 | 17.21 | 17.31 | 17.37 |
| **5** | 2384 | 25.48 | 17.22 | 17.40 | 17.26 | 17.11 | 17.23 | 17.21 |
| **6** | 2481 | 26.52 | 17.08 | 17.34 | 17.14 | 17.10 | 17.06 | 17.21 |
| **7** | 2383 | 25.47 | 17.20 | 17.47 | 17.11 | 17.11 | 17.35 | 17.38 |
| **8** | 2383 | 25.47 | 17.22 | 17.45 | 17.26 | 17.16 | 17.22 | 17.28 |
| **9** | 2385 | 25.49 | 17.27 | 17.49 | 17.29 | 17.26 | 17.29 | 17.34 |
| **10** | 2372 | 25.35 | 18.50 | 18.64 | 18.57 | 18.16 | 18.46 | 18.41 |
| **11** | 2384 | 25.48 | 18.67 | 18.82 | 18.78 | 18.50 | 18.62 | 18.60 |
| **12** | 2384 | 25.43 | 17.36 | 17.62 | 17.41 | 17.36 | 17.35 | 17.43 |
| **13** | 2387 | 25.51 | 17.25 | 17.47 | 17.23 | 17.19 | 17.30 | 17.39 |
| **14** | 2385 | 25.49 | 17.39 | 17.44 | 17.56 | 17.29 | 17.25 | 17.25 |
| **15** | 2387 | 25.51 | 17.08 | 17.35 | 17.08 | 17.07 | 17.13 | 17.26 |
| **16** | 2382 | 25.43 | 17.33 | 17.47 | 17.34 | 17.45 | 17.37 | 17.43 |
| **17** | 2383 | 25.44 | 17.27 | 17.31 | 17.43 | 17.16 | 17.14 | 17.12 |
| **18** | 2388 | 25.47 | 17.12 | 17.15 | 17.27 | 17.02 | 17.00 | 17.01 |
| **19** | 2385 | 25.52 | 16.99 | 17.24 | 16.96 | 16.94 | 17.06 | 17.08 |
| **20** | 2384 | 25.49 | 17.07 | 17.12 | 17.21 | 16.95 | 16.96 | 16.96 |
| **21** | 2382 | 25.48 | 17.16 | 17.19 | 17.28 | 16.95 | 17.08 | 17.08 |
| **22** | 2376 | 25.39 | 17.40 | 17.49 | 17.35 | 17.30 | 17.50 | 17.32 |
| **23** | 2386 | 25.50 | 17.13 | 17.26 | 17.06 | 17.01 | 17.24 | 17.15 |
| **24** | 2384 | 25.48 | 17.63 | 17.62 | 17.73 | 17.44 | 17.57 | 17.46 |

## 3.2 Species identification

There are occasions when it is not possible to identify an individual in the digital aerial survey image to the species level and the individual is identified as belonging to a higher-level group e.g. 'small gulls' or 'dolphin/porpoise'. The possible groups and the individual species that are included in the groups are listed in Table 5 for birds and Table 6 for marine mammals.

**Table 5 Individual and group level of bird species included in 'unidentified' groups during the May 2021 to April 2023 survey period**

| Species Level 1 | Group Level 2 | Group Level 3 | Group Level 4 | Group Level 5 |
|---|---|---|---|---|
| Great northern diver | Diver species | - | - | - |
| Red-throated diver | | | | |
| Kittiwake | Small gulls | | Gull species | Fulmar / Gull species |
| Common Gull | | | | |
| Great Black-backed Gull | Black-backed gulls | Large gulls | | |
| Lesser Black-backed Gull | | | | |
| Herring Gull | | | | |
| Fulmar | - | | - | |
| Common tern | 'Commic' tern | | Tern species | - |
| Arctic tern | | | | - |
| Guillemots | Guillemots / Razorbill | Auk species | | Auk / Shearwater species |
| Razorbill | | | | |
| Black guillemot | | | | |
| Puffin | | | | |
| Sooty shearwater | - | Large shearwater species | Shearwater species | |
| Manx shearwater | - | | | |

**Table 6 Individual and group level of marine mammal and shark species included in 'unidentified' groups during the May 2021 to April 2023 survey period**

| Species Level 1 | Group Level 2 | Group Level 3 | Group Level 4 |
|---|---|---|---|
| Grey seal | Seal species | | Unidentified marine mammal Species |
| Common dolphin | Dolphin Species | Dolphin / porpoise species | |
| White-beaked dolphin | | | |
| Bottlenose dolphin | | | |
| Risso's dolphin | | | |
| Harbour porpoise | Porpoise species | | |
| Common minke whale | Whale species | | |
| Basking shark | Shark species | | - |

The images were analysed to enumerate birds and marine mammals to species level, where possible. Targets identified from the images were 'snagged' (i.e. located within the images) and categorised. Yearly identification rates of species specific to Caledonia OWF surveys are presented in Table 7 and monthly identification rates are presented in Appendix 2 – Species identification rates. Unidentified bird species have not been included in the ID rate calculations due to the low number observed during the survey period (n=32 in year 1; n=36 in year 2) and the broadness of the grouping. Identification rate of an individual to the species level, from May 2021 to April 2023, specific to the Caledonia OWF project, are presented hereafter (Table 7). The ID rates were calculated from the raw counts of species observation in the Survey Area. In year 1, great skua, great northern diver, fulmar, gannet, white-beaked dolphin, harbour porpoise and common minke whale were all positively identified to species level and do not form part of the higher-level groupings. In year 2, pink-footed goose, great skua, Arctic skua, red-throated diver, gannet and basking shark were all positively identified to species level and do not form part of the higher-level groupings.

The species identification table represents a simple calculation of the proportion of each species recorded in the survey dataset. This approach provides a comparison of species frequencies without accounting for potential bias related to species rarity. It is important to acknowledge that less common species may appear to have lower identification percentages simply because they were less frequently captured in the imagery. This does not necessarily reflect a true identification rate but rather their relative abundance within the sampled population.

**Table 7 Yearly average of identification rate of species recorded to species level from a higher taxonomic grouping, within the Survey Area during the May 2021 to April 2023 survey period**

| Species common name | ID Species Level 1 (%) – Year 1: May 21 to April 22 | ID Species Level 1 (%) – Year 2: May 22 to Apr 23 |
|---|---|---|
| Pink-footed goose | - | 100% |
| Mallard | 100% | - |
| Kittiwake | 99.8% | 99.8% |
| Common gull | 64.3% | 36.4% |
| Great black-backed gull | 92.1% | 94.3% |
| Herring gull | 61.9% | 83.9% |
| Lesser black-backed gull | 8.1% | 50% |
| Common tern | 37.5% | - |
| Arctic tern | 64.3% | 42.9% |
| Great skua | 100% | 100% |
| Arctic skua | - | 100% |
| Guillemot | 78.4% | 90% |
| Razorbill | 31.3% | 53.8% |
| Black guillemot | 0.1% | 0.1% |
| Puffin | 76.5% | 81.1% |
| Great northern diver | 100% | - |
| Red-throated diver | - | 100% |
| Fulmar | 100% | 99.9% |
| Sooty shearwater | 2.5% | - |
| Manx shearwater | 32.8% | 8.5% |
| Gannet | 100% | 100% |
| Grey seal | 81.8% | 66.7% |
| Common dolphin | - | 88.6% |
| White-beaked dolphin | 100% | 80.8% |
| Bottlenose dolphin | - | 28.6% |
| Risso's dolphin | - | 58.3% |
| Harbour porpoise | 100% | 95.5% |
| Common minke whale | 100% | 66.7% |
| Basking shark | - | 100% |

### 3.3 Summary of quality assurance

Internal QA was carried out on the data collected from each of the surveys. Images were assessed in batches with a different staff member responsible for each batch. Each image containing birds was reviewed and checked by APEM's dedicated QA Manager, ensuring that 100% of birds and marine mammals found were subject to internal QA to ensure that species identification was correct. Images containing no birds and/or marine mammals were removed and kept separately for further internal QA. Of these 'blank' images, 10% were randomly selected for QA. If there was less than 90% agreement, the entire batch was re-analysed independently by a different staff member than the one who initially analysed the imagery.

### 3.4 Species abundance estimates

For each monthly digital aerial survey of the Survey Area, geo-referenced locations of birds or marine mammals contained within each individual digital still image were used to generate raw counts. Individual locations contained within the Survey Area were then extracted using QGIS, providing raw count data. These data are presented in this final report for all species recorded during both years of baseline surveys.

The raw counts were divided by the number of images collected to give the mean number of animals per image (i). Population estimates (N) for each survey month were then generated by multiplying the mean number of animals per image by the total number of images required to cover the entire study area (A):

$$N = i\,A$$

Non-parametric bootstrap methods were used for variance estimation. A variability statistic was generated by re-sampling 999 times with replacement from the raw count data. The statistic was evaluated from each of these 999 bootstrap samples and upper and lower 95% confidence intervals of these 999 values were taken as the variability of the statistic over the population (Efron & Tibshirani, 1993).

Measures of precision were calculated using a Poisson precision for the abundance estimates. This produced a CV (Coefficient of Variation) based on the relationship of the standard error to the mean (Thomas *et al.*, 2010). A target precision of ≤ 0.16 allows the detection of a population change of a factor as small as 2 (Bohlin, 1990).

All analysis and data manipulation carried out by APEM was conducted in the R programming language (R Development Core Team, 2021) and non-parametric 95% confidence intervals were generated using the 'boot' library of function (Canty & Ripley, 2022). This results in species-specific monthly abundance estimates being calculated from the raw count data, with upper and lower 95% confidence limits (Lower and Upper Confidence Limits, [LCL; UCL]). Where appropriate, a level of precision is also presented for each monthly abundance estimate. Dividing the monthly abundance estimates by the size of the Survey Area calculates the density (e.g. birds per $km^2$) for any given species. Abundance and density estimates presented in this report were calculated from the total raw count of individuals per species, recorded on a given month, regardless of the recorded behaviour (with the exception of deceased individuals, which were removed from the analysis, though these records are reported in Section 0).

### 3.5 Attribution and apportionment of unidentified individuals

Although the majority of individuals recorded from the surveys are identified to species level, a number remained identified to group level only. The abundance estimates with confidence limits within this annual report include attribution of unidentified individuals into the monthly abundance estimates and densities to account for these unidentified individuals. This is based on an apportionment of the group level identified individuals between those species within that group that were identified to species level within each individual monthly abundance estimate.

The number of unidentified individuals in a group is proportioned to the specific species that are contained within that group, based on the relative abundance of the positively identified species in that month's survey. Following the same methodology, confidence limits were also apportioned. For example, in the case of kittiwakes, the count consists of:

*Positively identified kittiwake + proportion of group level identified small gulls estimated to be kittiwakes calculated from positively identified small gull species.*

For instance, if 10 'small gull species' are recorded in June, and 20 kittiwakes and 20 common gulls are also recorded in June, the apportioning calculation will estimate that birds identified in June as 'small gull species are likely to consist of five kittiwakes and five common gulls.

In the 24 months surveys for the Survey Area, the individuals identified to group level contained within the dataset were:

Seabirds

- Wader species
- Black-backed gull species
- Large gull species
- Gull species
- 'Commic' tern
- Tern species
- Guillemot / razorbill
- Auk species
- Fulmar / gull species
- Small shearwater species
- Shearwater species
- Auk / shearwater species
- Thrush species
- Passerine species
- Bird species

Marine megafauna

- Seal species
- Dolphin species
- Dolphin / porpoise species
- Marine mammal species
- Shark species

Where no species-specific identification for common tern and Arctic tern is possible (size and plumage features are so similar that it is often difficult to separate them), they remain in the data as 'commic' tern. As a wide-ranging group, unidentified bird species counts (<0.01 % of the total of birds recorded across the two years in the Survey Area, n=54; Table 8) do not undergo apportionment.

In a given month, instances may have occurred when there were individuals only identified to group level rather than positively identified to species level. In such cases, apportionment of species abundance was undertaken, whereby individuals identified to group level were divided and assigned to month across the data, following a hierarchical approach using:

1. Same month, same year, same area (site or buffer only)
2. Same month, same year, same Survey Area (Site and Buffer)
3. Same month, same year, same Survey Area, larger buffer (if available)
4. Same bio-season/season, same year, same area (site or buffer only)
5. Same bio-season, same year, same Survey Area (Site and Buffer)
6. Same bio-season, same year, same Survey Area, larger buffer (if available)
7. Same month, different year, same area (site or buffer only)
8. Same month, different year, same Survey Area (Site and Buffer)
9. Same month, different year, same Survey Area, larger buffer (if available)
10. Same bio-season/season, different year, same area (site or buffer only)
11. Same bio-season/season, different year, same Survey Area (Site and Buffer)
12. Same bio-season/season, different year, same Survey Area, larger buffer (if available).

Bar plot diagrams created for key species (kittiwake, great black-backed gull, herring gull, great skua, guillemot, razorbill, puffin, fulmar, gannet) were created using where relevant, unapportioned, apportioned or apportioned and availability bias-corrected abundance estimates in the R programming language (R Development Core Team, 2021). Breeding and non-breeding seasons were also highlighted on the diagrams as per NatureScot (2024).

### 3.6 Availability bias

Diving birds, such as guillemots and razorbills, spend time foraging beneath the water surface. As a result of this, an unknown number of birds may go undetected due to the snapshot nature of aerial survey techniques (i.e. they are underwater, and therefore unavailable to be counted by the survey aircraft as it passes overhead). To account for this 'availability bias', a correction factor must be applied. This factor is applied to birds recorded on the sea only; birds in flight are assumed to be 100% available for detection and are therefore not included in these calculations.

The correction factors applied to guillemots and razorbills were based on that recommended by JNCC in a submission during the examination phase of the East Anglia ONE OWF, referred to by JNCC as Method C (JNCC, 2013). This applies a correction factor, on the basis of aerial surveys recording 76% of sitting guillemots and 83% of sitting razorbills, which assumes 24% and 17% of these species, respectively, will be underwater when aerial imagery is captured. The correction factor for puffins assumes 14% to be underwater at any time (Spencer, 2012). Therefore, to correct for availability bias the 'unavailable' birds are added to the bird totals on a monthly basis to create revised population estimates. The 'corrected' abundance estimates for guillemots and razorbills are presented in the relevant sections later in this report.

For marine mammals, it is possible from aerial imagery to capture individuals at the sea surface as well as underneath. Correction factors are applied to account for the availability bias of individuals which may be beneath the water surface at the moment an image is captured. For harbour porpoise, the seasonal correction factors from Voet *et al.* (2017) were applied to the total monthly abundance estimates (submerged and surfacing). The correction factors consider the probability of harbour porpoise being within the upper 2 m of the water column and therefore assumed to be detected by the aerial surveys (Teilmann *et al.*, 2013).

The average time spent at the water surface is not as well studied for other marine mammal species as it is for harbour porpoise, although some information does exist (e.g. grey seal, harbour seal, white-beaked dolphin bottlenose dolphin and Atlantic white-sided dolphin; see Voet *et al.*, 2017). Therefore, only abundance estimates for harbour porpoise were corrected for availability bias.

The corrected data for all species for which availability bias corrections were carried out are presented in the relevant species accounts in Section 4.

Specific text of the Method C for guillemot and razorbills, and puffin and harbour porpoises' correction factors are presented in the Appendix 3 – Correction factors.

### 3.7 Species distribution maps

Each individual identified within the digital still imagery is geo-referenced, allowing those locations to be related to the boundaries of the Survey Area, Caledonia North Survey Area, and Caledonia South Survey Area. The spatial distribution of each species within the Survey Area has been illustrated on a map, with the results presented in the Appendix 4 – Distribution maps.

### 3.8 Species flight direction rose diagrams

The flight direction of birds was recorded from all digital still images. Bearings of bird directions were plotted using the R programming language (R Development Core Team, 2021) to summarise overall directions of movement. The mean angle and mean vector are used to describe directional preferences and extent of 'agreement'. Length of the mean describes how the headings are clustered around the mean value and is graphically represented by a red arrow, with a vector (r) ranging value between 0 and 1. Arrow direction corresponds to the mean heading and the arrow length is proportional to its value. A Rayleigh test (Z) that assumes a null hypothesis of uniformity (i.e. scattered orientation in all directions) was used, where a significant test indicates directionality of movement. A larger value of r leads to a larger Z value, which would show that data is less likely to be normally (and uniformly) distributed. The critical value of the Rayleigh test of uniformity (Z) is graphically represented by a red circle. If the uniform distribution hypothesis is rejected ($p<0.05$), it will be graphically represented by the red arrow extending beyond the red circle. If the uniform distribution hypothesis is not rejected ($p>0.05$), i.e. there is no significant direction, it will be graphically represented by the red arrow falling within the red circle.

For each species, rose diagrams, where bird flight direction was significative ($p<0.05$), were presented in this report while rose diagrams, where bird flight direction was non-significative, were presented in Appendix 5 – Rose diagrams.

## 4. Species accounts

Across the 24 monthly surveys from May 2021 to April 2023, a total of 40,623 birds and 352 marine mammals and other megafauna were recorded in the Survey Area (Table 8, Table 11).

A total of 17,035 birds and 181 marine mammals and other megafauna were recorded during both years of baseline surveys in Caledonia North Survey Area (Table 9, Table 12).

A total of 30,317 birds and 249 marine mammals and other megafauna were recorded during both years of baseline surveys in Caledonia South Survey Area (Table 10, Table 13).

It should be noted that due to the spatial overlap between Caledonia North Survey Area and Caledonia South Survey Area, the total observations in each of these areas is greater than the total number of records made within the Survey Area.

The following species accounts present the raw counts, design-based abundance estimates, density estimates and distribution data from the twenty-four monthly digital aerial surveys in Caledonia OWF, Caledonia North and Caledonia South and respective buffers.

**Table 8 Summary of total raw counts of bird species recorded within the Survey Area during the May 2021 to April 2023 survey period**

| Bird Species | May 21 | Jun 21 | Jul 21 | Aug 21 | Sep 21 | Oct 21 | Nov 21 | Dec 21 | Jan 22 | Feb 22 | Mar 22 | Apr 22 | May 22 | Jun 22 | Jul 22 | Aug 22 | Sep 22 | Oct 22 | Nov 22 | Dec 22 | Jan 23 | Feb 23 | Mar 23 | Apr 23 | Grand total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Pink-footed goose | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 1 | - | - | - | 1 |
| Mallard | - | - | - | - | - | - | - | - | - | 2 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 2 |
| Wader species | - | - | - | - | - | - | - | - | - | - | - | - | - | 1 | - | - | - | - | - | - | - | - | - | - | 1 |
| Kittiwake | 195 | 358 | 1,083 | 294 | 158 | 85 | 143 | 27 | 8 | 29 | 42 | 100 | 677 | 813 | 920 | 144 | 50 | 32 | 17 | 8 | 5 | 33 | 16 | 129 | 5,366 |
| Common gull | - | - | - | - | 8 | - | 1 | - | - | - | - | - | - | - | - | 2 | - | - | - | 2 | - | - | - | - | 13 |
| Great black-backed gull | - | - | - | 3 | 76 | 46 | 163 | 15 | 48 | 43 | 2 | - | - | - | - | - | 12 | 38 | 19 | 22 | 33 | 15 | 5 | - | 540 |
| Herring gull | 1 | 1 | 16 | - | 1 | 7 | 14 | 3 | 1 | 7 | 1 | - | - | 1 | 29 | - | - | 3 | 3 | 8 | - | 2 | 1 | - | 99 |
| Lesser black-backed gull | - | - | 3 | - | - | - | - | - | - | - | - | - | 1 | 2 | 6 | - | - | - | - | - | - | - | - | - | 12 |
| Black-backed gull species | - | - | 1 | - | - | - | 2 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 3 |
| Large gull species | - | - | 2 | - | 4 | 5 | 16 | - | 1 | - | 1 | - | - | - | 12 | - | - | 1 | 1 | - | - | - | - | 1 | 44 |
| Gull species | 1 | - | 1 | 2 | - | - | - | - | - | 1 | - | - | - | - | - | 3 | - | - | - | 2 | - | - | - | - | 10 |
| Common tern | - | - | - | 3 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 3 |
| Arctic tern | 9 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 6 | - | - | - | - | - | - | - | - | 15 |
| 'Commic' tern | 3 | - | - | 2 | - | - | - | - | - | - | - | - | 6 | - | - | 8 | - | - | - | - | - | - | - | - | 19 |
| Tern species | 1 | - | 2 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 3 |
| Great skua | 1 | 2 | 10 | 6 | 1 | - | - | - | - | - | - | - | - | - | 2 | - | - | - | - | - | - | - | - | - | 22 |
| Arctic skua | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 2 | - | - | - | - | - | - | - | - | 2 |
| Guillemot | 1,944 | 1,047 | 2,687 | 115 | 808 | 266 | 421 | 18 | 88 | 145 | 130 | 448 | 3,127 | 2,299 | 2,595 | 157 | 2,038 | 116 | 15 | 81 | 147 | 448 | 503 | 494 | 20,137 |
| Razorbill | 178 | 160 | 296 | 61 | 80 | 10 | - | 6 | 8 | 59 | 13 | 148 | 406 | 35 | 198 | 60 | 514 | 8 | 16 | 17 | 20 | 66 | 84 | 99 | 2,542 |
| Guillemot / Razorbill | 172 | 401 | 77 | 401 | 174 | 78 | 33 | 208 | 35 | 212 | 55 | 50 | 313 | 48 | 226 | 38 | 232 | 83 | 30 | 17 | 6 | 36 | 44 | 27 | 2,996 |
| Black guillemot | - | 1 | - | - | - | - | - | - | - | - | - | 1 | - | 2 | - | - | - | - | - | - | - | - | - | - | 4 |
| Puffin | 102 | 84 | 107 | 562 | 25 | 39 | - | - | - | - | 2 | 194 | 204 | 25 | 38 | 137 | 495 | 4 | - | - | 5 | 7 | 14 | 10 | 2,054 |
| Auk species | 6 | 10 | 44 | 190 | 12 | 16 | - | - | 1 | 3 | 3 | 19 | 24 | 8 | 16 | 8 | 46 | 3 | 2 | 3 | 1 | 2 | 5 | 10 | 432 |
| Great northern diver | - | 1 | - | - | - | - | 1 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 2 |
| Red-throated diver | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 1 | - | - | - | - | - | - | 1 |
| Fulmar | 91 | 105 | 790 | 285 | 113 | 12 | 180 | 187 | 55 | 80 | 28 | 70 | 54 | 204 | 1,634 | 115 | 47 | 4 | 252 | 87 | 53 | 37 | 96 | 39 | 4,618 |
| Fulmar / Gull species | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 2 | - | - | - | 1 | - | 3 |
| Sooty shearwater | - | - | - | - | 1 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 1 |
| Manx shearwater | 1 | 15 | 3 | - | - | - | - | - | - | - | - | - | 9 | - | - | - | - | - | - | - | - | - | - | - | 28 |
| Small shearwater species | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 1 | 1 | - | - | - | - | - | - | - | 2 |
| Shearwater species | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 1 | - | - | - | - | - | - | - | 1 |
| Auk / shearwater species | 10 | 14 | 13 | - | - | - | - | - | - | - | - | 2 | 9 | 5 | - | 1 | 74 | - | - | - | - | - | 4 | 1 | 133 |
| Gannet | 14 | 114 | 33 | 71 | 99 | 125 | 16 | 4 | 2 | 5 | 1 | 12 | 22 | 267 | 110 | 12 | 105 | 47 | 2 | 5 | 3 | 8 | 1 | 15 | 1,093 |
| Thrush species | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 289 | - | - | - | - | - | - | 289 |
| Passerine species | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 78 | - | - | - | - | - | - | 78 |
| Bird species | 8 | 3 | 2 | 3 | 2 | 1 | - | 6 | 5 | 1 | 1 | - | 3 | 4 | 9 | 1 | 1 | 2 | 1 | 1 | - | - | - | - | 54 |
| **Grand Total** | **2,737** | **2,316** | **5,170** | **1,998** | **1,562** | **690** | **990** | **474** | **252** | **587** | **279** | **1,044** | **4,855** | **3,714** | **5,795** | **695** | **3,616** | **709** | **360** | **253** | **274** | **654** | **774** | **825** | **40,623** |

**Table 9 Summary of total raw counts of bird species recorded within Caledonia North Survey Area during the May 2021 to April 2023 survey period**

| Bird Species | May 21 | Jun 21 | Jul 21 | Aug 21 | Sep 21 | Oct 21 | Nov 21 | Dec 21 | Jan 22 | Feb 22 | Mar 22 | Apr 22 | May 22 | Jun 22 | Jul 22 | Aug 22 | Sep 22 | Oct 22 | Nov 22 | Dec 22 | Jan 23 | Feb 23 | Mar 23 | Apr 23 | Grand total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Pink-footed goose | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 1 | - | - | - | 1 |
| Mallard | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 0 |
| Wader species | - | - | - | - | - | - | - | - | - | - | - | - | - | 1 | - | - | - | - | - | - | - | - | - | - | 1 |
| Kittiwake | 81 | 81 | 513 | 75 | 15 | 52 | 138 | 18 | 7 | 21 | 35 | 35 | 532 | 300 | 317 | 73 | 22 | 4 | 13 | 5 | 4 | 15 | 8 | 9 | 2,373 |
| Common gull | - | - | - | - | 2 | - | 1 | - | - | - | - | - | - | - | - | 2 | - | - | - | 2 | - | - | - | - | 7 |
| Great black-backed gull | - | - | - | 3 | 76 | 46 | 84 | 9 | 37 | 23 | 2 | - | - | - | - | - | 10 | 22 | 12 | 16 | 22 | 11 | 3 | - | 376 |
| Herring gull | 1 | - | 16 | - | 1 | 7 | 9 | 2 | - | 1 | 1 | - | - | 1 | 12 | - | - | 1 | 1 | 5 | - | - | 1 | - | 59 |
| Lesser black-backed gull | - | - | 3 | - | - | - | - | - | - | - | - | - | 1 | 2 | - | - | - | - | - | - | - | - | - | - | 6 |
| Black-backed gull species | - | - | 1 | - | - | - | 1 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 2 |
| Large gull species | - | - | 2 | - | 4 | 5 | 7 | - | 1 | - | 1 | - | - | - | - | - | - | 1 | - | - | - | - | - | - | 21 |
| Gull species | - | - | 1 | 2 | - | - | - | - | - | 1 | - | - | - | - | - | 1 | - | - | - | 1 | - | - | - | - | 6 |
| Common tern | - | - | - | 3 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 3 |
| Arctic tern | 3 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 3 |
| 'Commic' tern | - | - | - | 2 | - | - | - | - | - | - | - | - | 6 | - | - | 1 | - | - | - | - | - | - | - | - | 9 |
| Tern species | - | - | 2 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 2 |
| Great skua | 1 | 2 | 5 | 6 | - | - | - | - | - | - | - | - | - | - | 2 | - | - | - | - | - | - | - | - | - | 16 |
| Arctic skua | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 1 | - | - | - | - | - | - | - | - | 1 |
| Guillemot | 560 | 385 | 993 | 38 | 112 | 64 | 180 | 9 | 41 | 46 | 45 | 170 | 2,284 | 1,127 | 702 | 28 | 101 | 25 | 4 | 44 | 62 | 201 | 316 | 124 | 7,661 |
| Razorbill | 99 | 47 | 112 | 44 | 24 | 2 | - | 2 | 1 | 37 | 9 | 82 | 314 | 22 | 77 | 30 | 371 | 8 | 9 | 9 | 12 | 17 | 53 | 14 | 1,395 |
| Guillemot / Razorbill | 68 | 74 | 31 | 44 | 66 | 26 | 19 | 85 | 19 | 112 | 28 | 16 | 217 | 32 | 63 | 24 | 91 | 49 | 22 | 12 | 4 | 23 | 29 | 9 | 1,163 |
| Black guillemot | - | 1 | - | - | - | - | - | - | - | - | - | - | - | 1 | - | - | - | - | - | - | - | - | - | - | 2 |
| Puffin | 59 | 38 | 46 | 418 | 14 | 16 | - | - | - | - | - | 104 | 105 | 11 | 18 | 29 | 302 | 4 | - | - | 5 | 4 | 8 | 4 | 1,185 |
| Auk species | 3 | 3 | 18 | 21 | 7 | 10 | - | - | 1 | 3 | 1 | 9 | 16 | 2 | 6 | 1 | 30 | 3 | - | 3 | 1 | 1 | 4 | 8 | 151 |
| Great northern diver | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 0 |
| Red-throated diver | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 1 | - | - | - | - | - | - | 1 |
| Fulmar | 62 | 53 | 215 | 179 | 54 | 1 | 45 | 87 | 37 | 37 | 22 | 24 | 30 | 130 | 405 | 62 | 19 | - | 167 | 60 | 26 | 21 | 55 | 27 | 1,818 |
| Fulmar / Gull species | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 1 | - | - | - | 1 | - | 2 |
| Sooty shearwater | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 0 |
| Manx shearwater | - | 1 | 1 | - | - | - | - | - | - | - | - | - | 3 | - | - | - | - | - | - | - | - | - | - | - | 5 |
| Small shearwater species | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 0 |
| Shearwater species | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 0 |
| Auk / shearwater species | 6 | 1 | 7 | - | - | - | - | - | - | - | - | 2 | 6 | 4 | - | - | 1 | 1 | - | - | - | - | 2 | - | 30 |
| Gannet | 8 | 51 | 9 | 26 | 60 | 89 | 6 | 2 | - | - | - | 4 | 7 | 74 | 25 | 7 | 46 | 10 | - | 3 | 1 | 6 | - | 1 | 435 |
| Thrush species | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 214 | - | - | - | - | - | - | 214 |
| Passerine species | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 57 | - | - | - | - | - | - | 57 |
| Bird species | - | 2 | 1 | 2 | 2 | - | - | 3 | 2 | 1 | 1 | - | 3 | 2 | 6 | 1 | 1 | 1 | 1 | 1 | - | - | - | - | 30 |
| **Grand Total** | **951** | **739** | **1,976** | **863** | **437** | **318** | **490** | **217** | **146** | **282** | **145** | **446** | **3,524** | **1,709** | **1,633** | **260** | **994** | **401** | **230** | **161** | **138** | **299** | **480** | **196** | **17,035** |

**Table 10 Summary of total raw counts of bird species recorded within Caledonia South Survey Area during the May 2021 to April 2023 survey period**

| Bird Species | May 21 | Jun 21 | Jul 21 | Aug 21 | Sep 21 | Oct 21 | Nov 21 | Dec 21 | Jan 22 | Feb 22 | Mar 22 | Apr 22 | May 22 | Jun 22 | Jul 22 | Aug 22 | Sep 22 | Oct 22 | Nov 22 | Dec 22 | Jan 23 | Feb 23 | Mar 23 | Apr 23 | Grand total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Pink-footed goose | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | **0** |
| Mallard | - | - | - | - | - | - | - | - | - | 2 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | **2** |
| Wader species | - | - | - | - | - | - | - | - | - | - | - | - | - | 1 | - | - | - | - | - | - | - | - | - | - | **1** |
| Kittiwake | 139 | 312 | 857 | 247 | 148 | 46 | 61 | 17 | 4 | 11 | 15 | 80 | 236 | 680 | 861 | 92 | 35 | 31 | 13 | 5 | 2 | 21 | 13 | 123 | **4,049** |
| Common gull | - | - | - | - | 6 | - | - | - | - | - | - | - | - | - | - | 2 | - | - | - | 1 | - | - | - | - | **9** |
| Great black-backed gull | - | - | - | - | 14 | 1 | 96 | 7 | 26 | 30 | 1 | - | - | - | - | - | 4 | 24 | 14 | 11 | 18 | 9 | 3 | - | **258** |
| Herring gull | - | 1 | - | - | - | - | 8 | 2 | 1 | 7 | - | - | - | - | 28 | - | - | 2 | 3 | 6 | - | 2 | - | - | **60** |
| Lesser black-backed gull | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 6 | - | - | - | - | - | - | - | - | - | **6** |
| Black-backed gull species | - | - | - | - | - | - | 1 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | **1** |
| Large gull species | - | - | 1 | - | - | 1 | 14 | - | - | - | 1 | - | - | - | 12 | - | - | - | 1 | - | - | - | - | 1 | **31** |
| Gull species | 1 | - | - | 1 | - | - | - | - | - | - | - | - | - | - | - | 1 | - | - | - | 1 | - | - | - | - | **4** |
| Common tern | - | - | - | 3 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | **3** |
| Arctic tern | 6 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | **6** | - | - | - | - | - | - | - | - | **12** |
| 'Commic' tern | 3 | - | - | 2 | - | - | - | - | - | - | - | - | 2 | - | - | 7 | - | - | - | - | - | - | - | - | **14** |
| Tern species | 1 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | **1** |
| Great skua | - | 2 | 5 | 2 | 1 | - | - | - | - | - | - | - | - | - | 1 | - | - | - | - | - | - | - | - | - | **11** |
| Arctic skua | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 2 | - | - | - | - | - | - | - | - | **2** |
| Guillemot | 1,602 | 825 | 2,175 | 93 | 758 | 240 | 329 | 14 | 67 | 117 | 113 | 375 | 1,508 | 1,563 | 2,278 | 140 | 1,982 | 96 | 12 | 53 | 114 | 331 | 357 | 437 | **15,579** |
| Razorbill | 99 | 131 | 244 | 26 | 67 | 10 | - | 5 | 7 | 27 | 6 | 100 | 185 | 21 | 158 | 47 | 243 | 1 | 13 | 10 | 14 | 54 | 57 | 92 | **1,617** |
| Guillemot / Razorbill | 125 | 354 | 59 | 376 | 136 | 71 | 27 | 150 | 25 | 121 | 38 | 45 | 151 | 34 | 183 | 20 | 170 | 57 | 26 | 11 | 4 | 28 | 29 | 21 | **2,261** |
| Black guillemot | - | 1 | - | - | - | - | - | - | - | - | - | 1 | - | 1 | - | - | - | - | - | - | - | - | - | - | **3** |
| Puffin | 61 | 76 | 88 | 309 | 21 | 31 | - | - | - | - | 2 | 116 | 149 | 18 | 29 | 126 | 283 | 1 | - | - | - | 4 | 9 | 6 | **1,329** |
| Auk species | 3 | 8 | 37 | 183 | 7 | 12 | - | - | - | - | 2 | 13 | 10 | 7 | 13 | 7 | 29 | 2 | 2 | 1 | - | 1 | 3 | 4 | **344** |
| Great northern diver | - | 1 | - | - | - | - | 1 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | **2** |
| Red-throated diver | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 1 | - | - | - | - | - | - | **1** |
| Fulmar | 46 | 75 | 673 | 178 | 96 | 11 | 136 | 125 | 31 | 56 | 10 | 56 | 31 | 109 | 1,441 | 76 | 38 | 4 | 140 | 52 | 36 | 22 | 54 | 15 | **3,511** |
| Fulmar / Gull species | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 1 | - | - | - | 1 | - | **2** |
| Sooty shearwater | - | - | - | - | 1 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | **1** |
| Manx shearwater | 1 | 15 | 2 | - | - | - | - | - | - | - | - | - | 8 | - | - | - | - | - | - | - | - | - | - | - | **26** |
| Small shearwater species | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 1 | 1 | - | - | - | - | - | - | - | **2** |
| Shearwater species | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 1 | - | - | - | - | - | - | - | **1** |
| Auk / shearwater species | 5 | 14 | 10 | - | - | - | - | - | - | - | - | - | 3 | 4 | - | - | 73 | - | - | - | - | - | 2 | 1 | **112** |
| Gannet | 8 | 79 | 28 | 57 | 47 | 82 | 14 | 2 | 2 | 5 | 1 | 10 | 16 | 222 | 69 | 9 | 86 | 42 | 2 | 3 | 3 | **3** | 1 | 16 | **807** |
| Thrush species | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 188 | - | - | - | - | - | - | **188** |
| Passerine species | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 37 | - | - | - | - | - | - | **37** |
| Bird species | 8 | 2 | 2 | 1 | - | 1 | - | 3 | 3 | - | - | - | 1 | 3 | 5 | - | - | 1 | - | - | - | - | - | - | **30** |
| **Grand Total** | **2,108** | **1,896** | **4,181** | **1,478** | **1,302** | **506** | **687** | **325** | **166** | **376** | **189** | **796** | **2,300** | **2,663** | **5,084** | **536** | **2,945** | **487** | **227** | **154** | **191** | **475** | **529** | **716** | **30,317** |

**Table 11 Summary of total raw counts of marine mammal and shark species recorded within the Survey Area during the May 2021 to April 2023 survey period**

| Marine mammal and other megafauna Species | May 21 | Jun 21 | Jul 21 | Aug 21 | Sep 21 | Oct 21 | Nov 21 | Dec 21 | Jan 22 | Feb 22 | Mar 22 | Apr 22 | May 22 | Jun 22 | Jul 22 | Aug 22 | Sep 22 | Oct 22 | Nov 22 | Dec 22 | Jan 23 | Feb 23 | Mar 23 | Apr 23 | Grand total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Grey seal | - | 1 | - | - | 3 | 2 | 2 | - | 1 | - | - | - | - | 2 | - | 2 | 1 | 4 | 1 | 1 | 2 | 2 | 2 | - | 26 |
| Seal species | 1 | 2 | 2 | - | - | - | - | - | - | 1 | 1 | - | - | 1 | - | - | - | - | 1 | 2 | - | 1 | 1 | - | 13 |
| Common dolphin | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 39 | - | - | - | - | - | - | 39 |
| White-beaked dolphin | - | - | - | - | 2 | 2 | 8 | 7 | 3 | 8 | - | - | - | - | - | - | 14 | 9 | - | - | 5 | 6 | - | - | 64 |
| Bottlenose dolphin | - | - | - | - | - | - | - | - | - | - | - | - | 2 | - | - | - | - | - | - | - | - | - | - | - | 2 |
| Risso's dolphin | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 2 | 5 | - | - | - | - | - | - | - | 7 |
| Dolphin species | - | 1 | - | - | - | - | - | - | 2 | - | - | - | - | - | - | - | - | - | - | - | - | - | -- | - | 3 |
| Harbour porpoise | 3 | 2 | 2 | - | 3 | 12 | - | 4 | - | 2 | 8 | 6 | 10 | 22 | 19 | 8 | 9 | - | 4 | 1 | 3 | 9 | 10 | 4 | 141 |
| Dolphin / porpoise species | 4 | 1 | 3 | - | 2 | 8 | 6 | - | 1 | 2 | 2 | - | 1 | 4 | - | - | - | 2 | - | - | - | - | - | 3 | 39 |
| Common minke whale | - | - | 6 | - | - | - | - | - | - | - | - | - | 1 | 2 | 3 | - | - | - | - | - | - | - | - | - | 12 |
| Marine mammal species | - | - | - | 1 | - | - | - | - | - | - | - | - | - | 2 | - | - | - | - | - | 1 | - | - | - | - | 4 |
| Basking shark | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 1 | - | - | - | - | - | 1 |
| Shark species | - | - | - | - | - | - | - | - | 1 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 1 |
| **Grand Total** | **8** | **7** | **13** | **1** | **10** | **24** | **16** | **11** | **8** | **13** | **11** | **6** | **14** | **33** | **22** | **12** | **29** | **54** | **7** | **5** | **10** | **18** | **13** | **7** | **352** |

**Table 12 Summary of total raw counts of marine mammal and shark species recorded within Caledonia North Survey Area during the May 2021 to April 2023 survey period**

| Marine mammal and other megafauna Species | May 21 | Jun 21 | Jul 21 | Aug 21 | Sep 21 | Oct 21 | Nov 21 | Dec 21 | Jan 22 | Feb 22 | Mar 22 | Apr 22 | May 22 | Jun 22 | Jul 22 | Aug 22 | Sep 22 | Oct 22 | Nov 22 | Dec 22 | Jan 23 | Feb 23 | Mar 23 | Apr 23 | Grand total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Grey seal | - | - | - | - | 2 | 1 | 1 | - | 1 | - | - | - | - | 2 | - | 2 | 1 | 4 | 1 | 1 | 2 | 1 | 1 | - | 20 |
| Seal species | 1 | 2 | 2 | - | - | - | - | - | - | 1 | - | - | - | - | - | - | - | - | - | 1 | - | - | 1 | - | 8 |
| Common dolphin | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 0 |
| White-beaked dolphin | - | - | - | - | - | 2 | 8 | - | - | 8 | - | - | - | - | - | - | 8 | 9 | - | - | 2 | 6 | - | - | 43 |
| Bottlenose dolphin | - | - | - | - | - | - | - | - | - | - | - | - | 2 | - | - | - | - | - | - | - | - | - | - | - | 2 |
| Risso's dolphin | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 5 | - | - | - | - | - | - | - | 5 |
| Dolphin species | - | 1 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 1 |
| Harbour porpoise | 1 | 2 | - | - | 3 | 11 | - | 1 | - | 2 | 4 | 5 | 2 | 9 | 14 | 3 | 6 | - | 3 | - | 2 | - | 4 | 3 | 75 |
| Dolphin / porpoise species | 1 | - | 2 | - | 2 | 8 | 4 | - | - | 2 | 1 | - | - | 1 | - | - | - | - | - | - | - | - | - | 1 | 22 |
| Common minke whale | - | - | 2 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 2 |
| Marine mammal species | - | - | - | 1 | - | - | - | - | - | - | - | - | - | 2 | - | - | - | - | - | - | - | - | - | - | 3 |
| Basking shark | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 0 |
| Shark species | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 0 |
| **Grand Total** | **3** | **5** | **6** | **1** | **7** | **22** | **13** | **1** | **1** | **13** | **5** | **5** | **4** | **14** | **14** | **5** | **20** | **13** | **4** | **2** | **6** | **7** | **6** | **4** | **181** |

**Table 13 Summary of total raw counts of marine mammal and shark species recorded within Caledonia South Survey Area during the May 2021 to April 2023 survey period**

| Marine mammal and other megafauna Species | May 21 | Jun 21 | Jul 21 | Aug 21 | Sep 21 | Oct 21 | Nov 21 | Dec 21 | Jan 22 | Feb 22 | Mar 22 | Apr 22 | May 22 | Jun 22 | Jul 22 | Aug 22 | Sep 22 | Oct 22 | Nov 22 | Dec 22 | Jan 23 | Feb 23 | Mar 23 | Apr 23 | Grand total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Grey seal | - | 1 | - | - | 1 | 1 | 2 | - | - | - | - | - | - | 1 | - | 2 | 1 | 1 | 1 | - | - | 2 | 1 | - | **14** |
| Seal species | - | - | 1 | - | - | - | - | - | - | - | 1 | - | - | 1 | - | - | - | - | 1 | 1 | - | 1 | 1 | - | **7** |
| Common dolphin | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 39 | - | - | - | - | - | - | **39** |
| White-beaked dolphin | - | - | - | - | 2 | - | 8 | 7 | 3 | 8 | - | - | - | - | - | - | 6 | - | - | - | 3 | - | - | - | **37** |
| Bottlenose dolphin | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | **0** |
| Risso's dolphin | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 2 | - | - | - | - | - | - | - | - | **2** |
| Dolphin species | - | 1 | - | - | - | - | - | - | 2 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | **3** |
| Harbour porpoise | 3 | 1 | 2 | - | 1 | 10 | - | 4 | - | - | 5 | 3 | 9 | 14 | 14 | 7 | 5 | - | 2 | 1 | 2 | 9 | 8 | 2 | **102** |
| Dolphin / porpoise species | 3 | 1 | 1 | - | 1 | 8 | 3 | - | 1 | 2 | 2 | - | 1 | 3 | - | - | - | 2 | - | - | - | - | - | 2 | **30** |
| Common minke whale | - | - | 5 | - | - | - | - | - | - | - | - | - | 1 | 2 | 3 | - | - | - | - | - | - | - | - | - | **11** |
| Marine mammal species | - | - | - | - | - | - | - | - | - | - | - | - | - | 1 | - | - | - | - | - | 1 | - | - | - | - | **2** |
| Basking shark | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 1 | - | - | - | - | - | **1** |
| Shark species | - | - | - | - | - | - | - | - | 1 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | **1** |
| **Grand Total** | **6** | **4** | **9** | **0** | **5** | **19** | **13** | **11** | **7** | **10** | **8** | **3** | **11** | **22** | **17** | **11** | **12** | **42** | **5** | **3** | **5** | **12** | **10** | **4** | **249** |

## 4.1 Pink-footed goose

### *i. Abundance and density estimates*

A pink-footed goose was recorded in the Survey Area in January 2023, specifically in Caledonia North (Table 8, Table 14 to Table 15). Abundance and density estimates are therefore very low (Table 14 to Table 15).

**Table 14 Raw counts, unapportioned and apportioned abundance and density estimates (birds per km$^2$) of pink-footed geese in Caledonia OWF, Caledonia OWF plus 2 km buffer and the Survey Area during the May 2021 to April 2023 survey period**

| Survey | Raw count | Total unapportioned | | | | | Total apportioned | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Abundance | LCL | UCL | Precision (CV) | Density (km$^2$) | Abundance | LCL | UCL | Density (km$^2$) |
| a) Caledonia OWF | | | | | | | | | | |
| Jan-23 | 1 | 6 | 1 | 17 | 1.00 | 0.01 | 6 | 1 | 17 | 0.01 |
| b) Caledonia OWF plus 2 km buffer | | | | | | | | | | |
| Jan-23 | 1 | 6 | 1 | 17 | 1.00 | 0.01 | 6 | 1 | 17 | 0.01 |
| c) Survey Area | | | | | | | | | | |
| Jan-23 | 1 | 6 | 1 | 18 | 1.00 | 0.01 | 6 | 1 | 18 | 0.01 |

**Table 15 Raw counts, unapportioned and apportioned abundance and density estimates (birds per km$^2$) of pink-footed geese in Caledonia North, Caledonia North plus 2 km buffer and Caledonia North Survey Area during the May 2021 to April 2023 survey period**

| Survey | Raw count | Total unapportioned | | | | | Total apportioned | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Abundance | LCL | UCL | Precision (CV) | Density (km$^2$) | Abundance | LCL | UCL | Density (km$^2$) |
| a) Caledonia North | | | | | | | | | | |
| Jan-23 | 1 | 6 | 1 | 17 | 1.00 | 0.03 | 6 | 1 | 17 | 0.03 |
| b) Caledonia North plus 2 km buffer | | | | | | | | | | |
| Jan-23 | 1 | 6 | 1 | 17 | 1.00 | 0.02 | 6 | 1 | 17 | 0.02 |
| c) Caledonia North Survey Area | | | | | | | | | | |
| Jan-23 | 1 | 6 | 1 | 17 | 1.00 | 0.01 | 6 | 1 | 18 | 0.01 |

**Table 16 Raw counts, unapportioned and apportioned abundance and density estimates (birds per km$^2$) of pink-footed geese in Caledonia South, Caledonia South plus 2 km buffer and Caledonia South Survey Area during the May 2021 to April 2023 survey period**

| Survey | Raw count | Total unapportioned | | | | | Total apportioned | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Abundance | LCL | UCL | Precision (CV) | Density (km$^2$) | Abundance | LCL | UCL | Density (km$^2$) |
| a) Caledonia South | | | | | | | | | | |
| None recorded | | | | | | | | | | |
| b) Caledonia South plus 2 km buffer | | | | | | | | | | |
| None recorded | | | | | | | | | | |
| c) Caledonia South Survey Area | | | | | | | | | | |
| None recorded | | | | | | | | | | |

### *ii. Distribution and behaviour*

The single pink-footed goose was recorded in January 2023 within Caledonia OWF, specifically in the south of Caledonia North, near the subdivision line with Caledonia South (Appendix 4, Figure A4.1).

As only one bird was recorded in flight, they were too infrequent to determine any preference in flight direction (Appendix 5, Figure A5.1).

## 4.2 Mallard

### *i. Abundance and density estimates*

Two mallards were recorded in the Survey Area in February 2022 (Table 8, Table 17 to Table 29), specifically in Caledonia South (Table 17, Table 29). Abundance and density estimates are therefore very low (Table 17 to Table 29).

**Table 17 Raw counts, unapportioned and apportioned abundance and density estimates (birds per km$^2$) of mallards in Caledonia OWF, Caledonia OWF plus 2 km buffer and the Survey Area during the May 2021 to April 2023 survey period**

| Survey | Raw count | Total, unapportioned | | | | | Total apportioned | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Abundance | LCL | UCL | Precision (CV) | Density (km$^2$) | Abundance | LCL | UCL | Density (km$^2$) |
| **a) Caledonia OWF** | | | | | | | | | | |
| **Feb-22** | 2 | 11 | 2 | 32 | 0.71 | 0.03 | 11 | 2 | 32 | 0.03 |
| **b) Caledonia OWF plus 2 km buffer** | | | | | | | | | | |
| **Feb-22** | 2 | 11 | 2 | 32 | 0.71 | 0.02 | 11 | 2 | 32 | 0.02 |
| **c) Survey Area** | | | | | | | | | | |
| **Feb-22** | 2 | 11 | 2 | 33 | 0.71 | 0.01 | 11 | 2 | 33 | 0.01 |

**Table 18 Raw counts, unapportioned and apportioned abundance and density estimates (birds per km$^2$) of mallards in Caledonia North, Caledonia North plus 2 km buffer and Caledonia South Survey Area during the May 2021 to April 2023 survey period**

| Survey | Raw count | Total unapportioned | | | | | Total apportioned | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Abundance | LCL | UCL | Precision (CV) | Density (km$^2$) | Abundance | LCL | UCL | Density (km$^2$) |
| **a) Caledonia North** | | | | | | | | | | |
| None recorded | | | | | | | | | | |
| **b) Caledonia North plus 2 km buffer** | | | | | | | | | | |
| None recorded | | | | | | | | | | |
| **c) Caledonia North Survey Area** | | | | | | | | | | |
| None recorded | | | | | | | | | | |

**Table 19 Raw counts, unapportioned and apportioned abundance and density estimates (birds per km$^2$) of mallards in Caledonia South, Caledonia South plus 2 km buffer and Caledonia South Survey Area during the May 2021 to April 2023 survey period**

| Survey | Raw count | Total unapportioned | | | | | Total apportioned | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Abundance | LCL | UCL | Precision (CV) | Density (km$^2$) | Abundance | LCL | UCL | Density (km$^2$) |
| **a) Caledonia South** | | | | | | | | | | |
| **Feb-22** | 2 | 11 | 2 | 32 | 0.71 | 0.05 | 11 | 2 | 32 | 0.05 |
| **b) Caledonia South plus 2 km buffer** | | | | | | | | | | |
| **Feb-22** | 2 | 11 | 2 | 32 | 0.71 | 0.03 | 11 | 2 | 32 | 0.03 |
| **c) Caledonia South Survey Area** | | | | | | | | | | |
| **Feb-22** | 2 | 11 | 2 | 32 | 0.71 | 0.02 | 11 | 2 | 33 | 0.02 |

### *ii. Distribution and behaviour*

Mallards were recorded in Caledonia South near the south border of the subdivision (Appendix 4, Figure A4.2).

As only two birds were recorded as flying, they were too infrequent to determine any preference in flight direction (Appendix 5, Figure A5.2).

## 4.3 Unidentified wader species

### *i. Abundance and density estimates*

A single wader species was recorded in the Survey Area during the second year of the baseline surveys. The wader species was recorded in June 2022, in Caledonia North Survey Area and Caledonia South Survey Area (Table 20 to Table 22). Abundance and density estimates are therefore very low (Table 20 to Table 22).

**Table 20 Raw counts, unapportioned abundance and density estimates (birds per km$^2$) of wader species in Caledonia OWF, Caledonia OWF plus 2 km buffer and the Survey Area during the May 2021 to April 2023 survey period**

| Survey | Raw count | Total unapportioned | | | | |
|---|---|---|---|---|---|---|
| | | Abundance | LCL | UCL | Precision (CV) | Density (km$^2$) |
| **a) Caledonia OWF** | | | | | | |
| None recorded | | | | | | |
| **b) Caledonia OWF plus 2 km buffer** | | | | | | |
| None recorded | | | | | | |
| **c) Survey Area** | | | | | | |
| **Jun-22** | 1 | 6 | 1 | 17 | 1.00 | 0.01 |

**Table 21 Raw counts, unapportioned abundance and density estimates (birds per km$^2$) of wader species in Caledonia North, Caledonia North plus 2 km buffer and Caledonia North Survey Area during the May 2021 to April 2023 survey period**

| Survey | Raw count | Total unapportioned | | | | |
|---|---|---|---|---|---|---|
| | | Abundance | LCL | UCL | Precision (CV) | Density (km$^2$) |
| **a) Caledonia North** | | | | | | |
| None recorded | | | | | | |
| **b) Caledonia North plus 2 km buffer** | | | | | | |
| None recorded | | | | | | |
| **c) Caledonia North Survey Area** | | | | | | |
| **Jun-22** | 1 | 6 | 1 | 17 | 1.00 | 0.01 |

**Table 22 Raw counts, unapportioned abundance and density estimates (birds per km$^2$) of wader species in Caledonia South, Caledonia South plus 2 km buffer and Caledonia South Survey Area during the May 2021 to April 2023 survey period**

| Survey | Raw count | Total unapportioned | | | | |
|---|---|---|---|---|---|---|
| | | Abundance | LCL | UCL | Precision (CV) | Density (km$^2$) |
| **a) Caledonia South** | | | | | | |
| None recorded | | | | | | |
| **b) Caledonia South plus 2 km buffer** | | | | | | |
| None recorded | | | | | | |
| **c) Caledonia South Survey Area** | | | | | | |
| **Jun-22** | 1 | 6 | 1 | 17 | 1.00 | 0.01 |

### *ii. Distribution and behaviour*

A single wader species was recorded in the southeast of Caledonia North Buffer Zone (Appendix 4, Figure A4.3).

As only one bird was recorded in flight, they were too infrequent to determine any preference in flight direction (Appendix 5, Figure A5.3).

## 4.4 Kittiwake

### *i. Abundance and density estimates*

#### *Caledonia OWF*

A total of 5,366 kittiwakes were recorded in the Survey Area during both years of baseline surveys (Table 8). Kittiwakes were recorded in every survey (Table 8, Table 23). Kittiwakes were the most abundant during the breeding season (April to August), with a peak of abundance in June 2022 in Caledonia OWF and Caledonia OWF plus 2 km buffer, and in July 2021 in the Survey Area (Table 23, Figure 2):

- 502 individuals were recorded in Caledonia OWF in June 2022, resulting in an unapportioned mean abundance estimate of 2,885 [1,109; 4,925] and an apportioned mean abundance estimate of 2,885 [868; 5,781] individuals. Both equated to a mean density estimate of 6.75 birds/km$^2$.
- 723 individuals were recorded in Caledonia OWF plus 2 km buffer in June 2022, resulting in an unapportioned mean abundance estimate of 4,142 [1,908; 6,761] and an apportioned mean abundance estimate of 4,142 [1,358; 8,005] individuals. These equated to mean density estimates of 6.44 (unapportioned) and 6.43 (apportioned) birds/km$^2$.
- 1,083 individuals were recorded in the Survey Area in July 2021, resulting in an unapportioned mean abundance estimate of 6,539 [1,787; 12,788] and apportioned mean abundance estimate of 6,545 [1,613; 12,890] individuals. Both equated to a mean density estimate of 7.40 birds/km$^2$.

In both breeding seasons covered by the baseline surveys, apportioned mean kittiwake abundances across the Survey Area grew steadily throughout the first half of the breeding season, with peaks observed in June (2022) or July (2021). This is likely associated at least in part with breeding adult birds carrying out foraging trips from nearby breeding colonies. Mean apportioned abundances were considerably lower in August 2021 and 2022 than the preceding months. This would be expected since this is the time at which birds tend to leave the seas close to breeding colonies, in order to spend the non-breeding season in more oceanic areas.

Reductions in mean apportioned abundance in the nine breeding season surveys, outside the survey month with the peak mean apportioned abundance (July 2021), varied from 8% to 93%, with most surveys falling somewhere in the middle of the two extremes of this range. This indicates that the mean apportioned abundances were highly variable throughout the breeding season surveys when compared with the peak mean apportioned abundance for the baseline survey period.

Kittiwake abundance was the lowest during the non-breeding season (September to March) with a wintering peak of abundance in November 2021 in Caledonia OWF, and September 2021 in Caledonia OWF plus 2 km buffer and the Survey Area (Table 23, Figure 2):

- 74 individuals were recorded in Caledonia OWF in November 2021, resulting in an unapportioned mean abundance estimate of 430 [197; 685] and an apportioned mean abundance estimate of 430 [198; 708] individuals. Both equated to a mean density estimate of 1.01 birds/km$^2$.
- 129 individuals were recorded in Caledonia OWF plus 2 km buffer in September 2021, resulting in an unapportioned mean abundance estimate of 741 [129; 1,969] and an apportioned mean abundance estimate of 741 [144; 1,998] individuals. Both equated to a mean density estimate of 1.15 birds/km$^2$.
- 158 individuals were recorded in the Survey Area in September 2021, resulting in an unapportioned mean abundance estimate of 925 [187; 2,341] and an apportioned mean

abundance estimate of 925 [219; 2,329] individuals. Both equated to a mean density estimate of 1.05 birds/km$^2$.

During the two non-breeding seasons covered by the baseline surveys, the trends observed in apportioned mean kittiwake abundance were characterised by relatively consistent and low apportioned mean abundances of birds across all reporting regions in the Survey Area. Apportioned mean abundances were lowest in the winter months across both survey years, with peak mean apportioned abundances occurring in the autumn. Most of the 13 surveys in the non-breeding season other than the peak month reported considerably lower mean apportioned abundances of birds than the peak month. Reductions in mean apportioned abundance relative to the peak were between 10% to 98%, with most surveys reporting reductions closer to the upper limit. This indicates that the mean apportioned abundances were highly variable throughout the breeding season surveys when compared with the peak mean apportioned abundance for the baseline survey period, with many of the surveys recording apportioned mean kittiwake abundances considerably lower than the peak mean apportioned abundance.

The 95% confidence intervals calculated for the mean abundances were often relatively high even for surveys where CV values were low (e.g. July 2021 for the Survey Area). This is perhaps a consequence of the numbers of birds in single samples (i.e. images) being highly variable. Where reporting regions were smaller (e.g. Caledonia OWF), it is possible that there was lower variability between samples, resulting in tighter 95% confidence intervals about the mean abundance estimate.

Good measures of precision were calculated for most survey months (CV ≤ 0.16; Table 23). This was particularly the case for months during the breeding season (April to August), which is when the majority of records of this species were made (Table 23). Within Caledonia OWF, a single survey during the breeding season had a precision value of CV > 0.16 (April 2022; 0.17; Table 23). Outside the breeding season, CV values of 0.2 to 0.4 for Caledonia OWF were more common (Table 23). For Caledonia OWF plus buffer regions, CV values were generally lower than the corresponding CV values for Caledonia OWF, indicating higher precision within these reporting regions (Table 23).

**Table 23 Raw counts, unapportioned and apportioned abundance and density estimates (birds per km$^2$) of kittiwakes in Caledonia OWF, Caledonia OWF plus 2 km buffer, and the Survey Area during the May 2021 to April 2023 survey period. Colour gradients follow the ascending order of kittiwake raw counts per season, with light yellow to orange (peak number) for the breeding season months (April to August) and light blue to royal blue (peak number) for the wintering months (September to March)**

| Survey | Raw count | Total unapportioned | | | | | Total apportioned | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Abundance | LCL | UCL | Precision (CV) | Density (km$^2$) | Abundance | LCL | UCL | Density (km$^2$) |
| a) Caledonia OWF | | | | | | | | | | |
| May-21 | 134 | 781 | 227 | 1,656 | 0.09 | 1.83 | 782 | 236 | 1,820 | 1.83 |
| Jun-21 | 175 | 1,027 | 340 | 2,178 | 0.08 | 2.4 | 1,027 | 381 | 2,325 | 2.4 |
| Jul-21 | 307 | 1,811 | 425 | 3,320 | 0.06 | 4.24 | 1,817 | 457 | 3,734 | 4.25 |
| Aug-21 | 62 | 359 | 255 | 492 | 0.13 | 0.84 | 359 | 232 | 498 | 0.84 |
| Sep-21 | 12 | 70 | 35 | 99 | 0.29 | 0.16 | 70 | 36 | 110 | 0.16 |
| Oct-21 | 35 | 205 | 99 | 322 | 0.17 | 0.48 | 204 | 98 | 322 | 0.48 |
| Nov-21 | 74 | 430 | 197 | 685 | 0.12 | 1.01 | 430 | 198 | 708 | 1.01 |
| Dec-21 | 10 | 58 | 17 | 104 | 0.32 | 0.14 | 58 | 18 | 104 | 0.14 |
| Jan-22 | 7 | 41 | 17 | 69 | 0.38 | 0.1 | 41 | 12 | 69 | 0.1 |
| Feb-22 | 14 | 76 | 22 | 135 | 0.27 | 0.18 | 76 | 18 | 146 | 0.18 |
| Mar-22 | 14 | 75 | 27 | 134 | 0.27 | 0.18 | 75 | 29 | 139 | 0.18 |
| Apr-22 | 36 | 207 | 138 | 288 | 0.17 | 0.48 | 207 | 133 | 288 | 0.48 |
| May-22 | 326 | 1,889 | 771 | 2,978 | 0.06 | 4.42 | 1,889 | 736 | 3,181 | 4.42 |
| Jun-22 | 502 | 2,885 | 1,109 | 4,925 | 0.04 | 6.75 | 2,885 | 868 | 5,781 | 6.75 |

| Survey | Raw count | Total unapportioned | | | | | Total apportioned | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Abundance | LCL | UCL | Precision (CV) | Density (km²) | Abundance | LCL | UCL | Density (km²) |
| Jul-22 | 202 | 1,182 | 351 | 2,515 | 0.07 | 2.77 | 1,182 | 379 | 2,615 | 2.76 |
| Aug-22 | 76 | 438 | 265 | 611 | 0.11 | 1.03 | 443 | 249 | 637 | 1.04 |
| Sep-22 | 24 | 139 | 69 | 226 | 0.20 | 0.33 | 139 | 51 | 278 | 0.33 |
| Oct-22 | 9 | 53 | 18 | 105 | 0.33 | 0.12 | 53 | 15 | 99 | 0.12 |
| Nov-22 | 10 | 59 | 10 | 129 | 0.32 | 0.14 | 59 | 10 | 136 | 0.14 |
| Dec-22 | 2 | 12 | 2 | 35 | 0.71 | 0.03 | 14 | 2 | 40 | 0.03 |
| Jan-23 | 2 | 12 | 2 | 23 | 0.71 | 0.03 | 12 | 2 | 29 | 0.03 |
| Feb-23 | 14 | 80 | 17 | 166 | 0.27 | 0.19 | 81 | 14 | 178 | 0.19 |
| Mar-23 | 4 | 23 | 6 | 41 | 0.50 | 0.05 | 24 | 4 | 55 | 0.06 |
| Apr-23 | 114 | 646 | 114 | 1,695 | 0.09 | 1.51 | 646 | 114 | 1,718 | 1.51 |
| b) | Caledonia OWF plus 2 km buffer | | | | | | | | | |
| May-21 | 161 | 925 | 373 | 1,787 | 0.08 | 1.44 | 931 | 381 | 1,941 | 1.45 |
| Jun-21 | 269 | 1,560 | 644 | 2,912 | 0.06 | 2.42 | 1,560 | 654 | 2,981 | 2.42 |
| Jul-21 | 657 | 3,806 | 741 | 7,965 | 0.04 | 5.91 | 3,811 | 802 | 8,185 | 5.92 |
| Aug-21 | 159 | 907 | 502 | 1,558 | 0.08 | 1.41 | 907 | 497 | 1,552 | 1.41 |
| Sep-21 | 129 | 741 | 129 | 1,969 | 0.09 | 1.15 | 741 | 144 | 1,998 | 1.15 |
| Oct-21 | 60 | 346 | 236 | 455 | 0.13 | 0.54 | 345 | 231 | 479 | 0.54 |
| Nov-21 | 101 | 578 | 309 | 881 | 0.10 | 0.9 | 578 | 265 | 876 | 0.9 |
| Dec-21 | 21 | 120 | 69 | 172 | 0.22 | 0.19 | 121 | 64 | 183 | 0.19 |
| Jan-22 | 7 | 40 | 11 | 69 | 0.38 | 0.06 | 40 | 17 | 74 | 0.06 |
| Feb-22 | 22 | 118 | 59 | 188 | 0.21 | 0.18 | 120 | 45 | 211 | 0.19 |
| Mar-22 | 20 | 106 | 48 | 180 | 0.22 | 0.16 | 106 | 45 | 180 | 0.16 |
| Apr-22 | 86 | 488 | 176 | 1,010 | 0.11 | 0.76 | 488 | 204 | 1,015 | 0.76 |
| May-22 | 607 | 3,472 | 1,830 | 5,143 | 0.04 | 5.4 | 3,472 | 1,636 | 5,681 | 5.39 |
| Jun-22 | 723 | 4,142 | 1,908 | 6,761 | 0.04 | 6.44 | 4,142 | 1,358 | 8,005 | 6.43 |
| Jul-22 | 332 | 1,912 | 829 | 3,553 | 0.05 | 2.97 | 1,912 | 818 | 3,714 | 2.97 |
| Aug-22 | 108 | 618 | 366 | 904 | 0.10 | 0.96 | 623 | 386 | 909 | 0.97 |
| Sep-22 | 39 | 225 | 144 | 312 | 0.16 | 0.35 | 225 | 93 | 398 | 0.35 |
| Oct-22 | 24 | 140 | 52 | 239 | 0.20 | 0.22 | 140 | 52 | 250 | 0.22 |
| Nov-22 | 15 | 87 | 15 | 185 | 0.26 | 0.14 | 87 | 17 | 198 | 0.14 |
| Dec-22 | 4 | 23 | 4 | 58 | 0.50 | 0.04 | 27 | 4 | 74 | 0.04 |
| Jan-23 | 3 | 17 | 3 | 35 | 0.58 | 0.03 | 17 | 3 | 35 | 0.03 |
| Feb-23 | 19 | 109 | 34 | 211 | 0.23 | 0.17 | 109 | 28 | 217 | 0.17 |
| Mar-23 | 11 | 64 | 29 | 104 | 0.30 | 0.1 | 65 | 18 | 113 | 0.1 |
| Apr-23 | 122 | 692 | 122 | 1,752 | 0.09 | 1.08 | 691 | 131 | 1,786 | 1.07 |
| c) | Survey Area | | | | | | | | | |
| May-21 | 195 | 1,140 | 532 | 1,993 | 0.07 | 1.29 | 1,146 | 535 | 2,216 | 1.3 |
| Jun-21 | 358 | 2,106 | 759 | 4,148 | 0.05 | 2.38 | 2,106 | 831 | 4,101 | 2.38 |
| Jul-21 | 1,083 | 6,539 | 1,787 | 12,788 | 0.03 | 7.4 | 6,545 | 1,613 | 12,890 | 7.4 |
| Aug-21 | 294 | 1,706 | 743 | 2,889 | 0.06 | 1.93 | 1,718 | 767 | 3,116 | 1.94 |
| Sep-21 | 158 | 925 | 187 | 2,341 | 0.08 | 1.05 | 925 | 219 | 2,329 | 1.05 |
| Oct-21 | 85 | 498 | 334 | 679 | 0.11 | 0.56 | 498 | 317 | 696 | 0.56 |
| Nov-21 | 143 | 832 | 501 | 1,199 | 0.08 | 0.94 | 832 | 449 | 1,258 | 0.94 |
| Dec-21 | 27 | 157 | 87 | 227 | 0.19 | 0.18 | 158 | 84 | 233 | 0.18 |
| Jan-22 | 8 | 46 | 17 | 81 | 0.35 | 0.05 | 46 | 17 | 81 | 0.05 |
| Feb-22 | 29 | 159 | 82 | 236 | 0.19 | 0.18 | 161 | 76 | 258 | 0.18 |
| Mar-22 | 42 | 227 | 113 | 340 | 0.15 | 0.26 | 227 | 114 | 351 | 0.26 |
| Apr-22 | 100 | 577 | 254 | 1,113 | 0.10 | 0.65 | 577 | 288 | 1,130 | 0.65 |
| May-22 | 677 | 3,931 | 1,980 | 5,922 | 0.04 | 4.45 | 3,931 | 1,754 | 6,521 | 4.45 |
| Jun-22 | 813 | 4,705 | 2,193 | 7,819 | 0.04 | 5.32 | 4,705 | 1,667 | 8,611 | 5.32 |
| Jul-22 | 920 | 5,377 | 1,625 | 10,269 | 0.03 | 6.08 | 5,377 | 1,882 | 10,257 | 6.08 |

| Survey | Raw count | Total unapportioned | | | | | Total apportioned | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Abundance | LCL | UCL | Precision (CV) | Density ($km^2$) | Abundance | LCL | UCL | Density ($km^2$) |
| **Aug-22** | 144 | 827 | 511 | 1,189 | 0.08 | 0.94 | 833 | 493 | 1,315 | 0.94 |
| **Sep-22** | 50 | 292 | 204 | 385 | 0.14 | 0.33 | 292 | 135 | 472 | 0.33 |
| **Oct-22** | 32 | 188 | 88 | 300 | 0.18 | 0.21 | 188 | 77 | 323 | 0.21 |
| **Nov-22** | 17 | 100 | 18 | 200 | 0.24 | 0.11 | 101 | 23 | 209 | 0.11 |
| **Dec-22** | 8 | 47 | 12 | 88 | 0.35 | 0.05 | 49 | 8 | 113 | 0.06 |
| **Jan-23** | 5 | 29 | 6 | 59 | 0.45 | 0.03 | 29 | 6 | 59 | 0.03 |
| **Feb-23** | 33 | 191 | 93 | 301 | 0.17 | 0.22 | 191 | 69 | 347 | 0.22 |
| **Mar-23** | 16 | 94 | 53 | 141 | 0.25 | 0.11 | 95 | 35 | 161 | 0.11 |
| **Apr-23** | 129 | 740 | 143 | 1,802 | 0.09 | 0.84 | 740 | 153 | 1,848 | 0.84 |

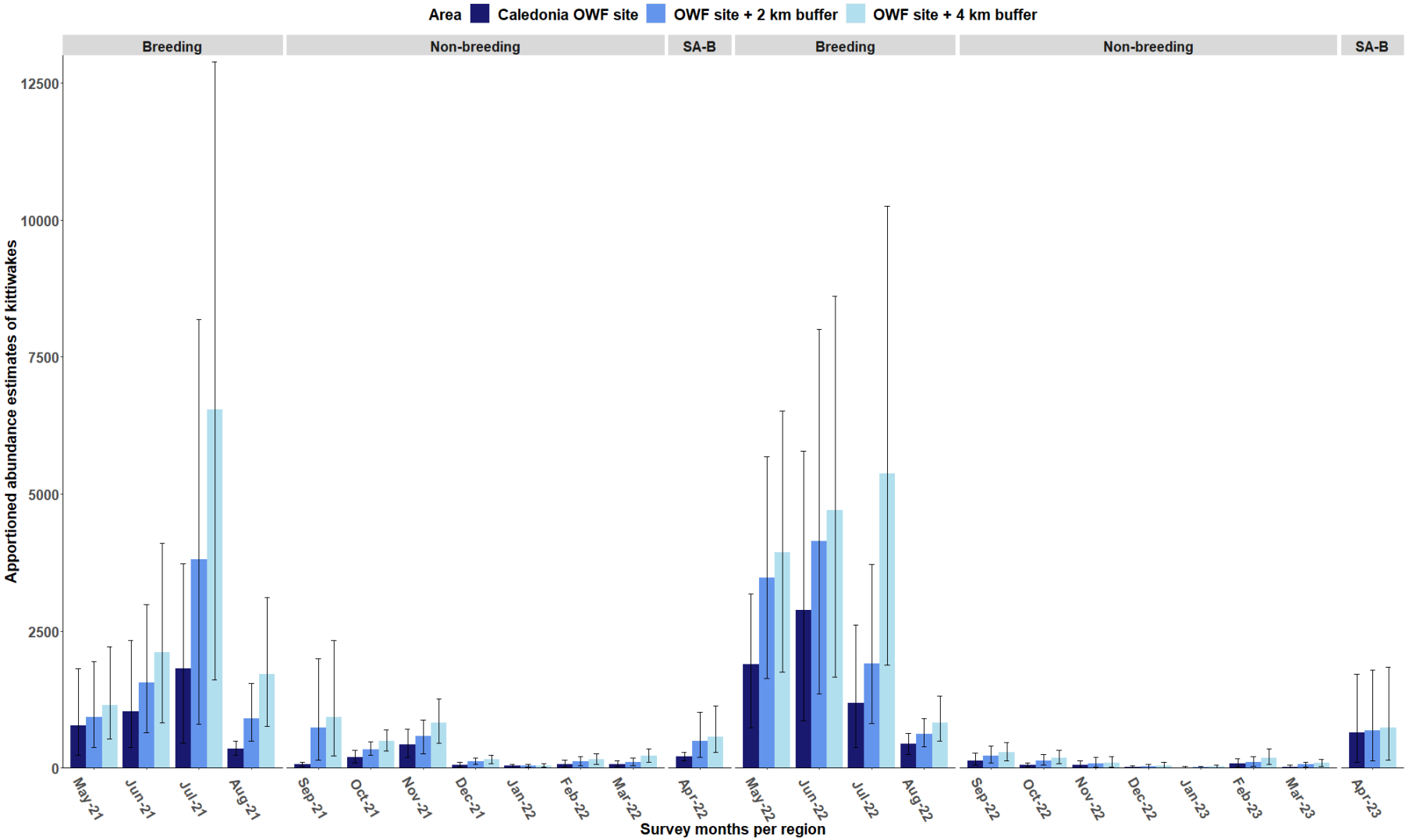



**Figure 2 Bar plot of monthly apportioned abundance estimates (with 95% confidence intervals) of the total kittiwakes recorded in each reporting region of the Survey Area, during the May 2021 to April 2023 survey period. Kittiwake seasonal periods are also displayed. SA-B corresponds to month split between breeding site attendance (SA) and breeding (B)**

### *Caledonia North*

A total of 2,373 kittiwakes were recorded in Caledonia North Survey Area during both years of baseline surveys (Table 9). Kittiwakes were recorded in every survey, except in December 2022 in Caledonia North (Table 24). Kittiwakes were the most abundant during kittiwake breeding season (April to August), with a peak of abundance in May 2022 (Table 24, Figure 3):

- 188 individuals were recorded in Caledonia North, resulting in an unapportioned mean abundance estimate of 1,091 [337; 1,805] and an apportioned mean abundance estimate of 1,091 [383; 1,857] individuals. These equated to mean density estimates of 5.00 (unapportioned) and 4.99 (apportioned) birds/km$^2$.
- 465 individuals were recorded in Caledonia North plus 2 km buffer, resulting in an unapportioned mean abundance estimate of 2,648 [1,196; 4,134] and an apportioned mean abundance estimate of 2,648 [1,065; 4,584] individuals. These equated to mean density estimates of 7.06 (unapportioned) and 7.05 (apportioned) birds/km$^2$.
- 532 individuals were recorded in Caledonia North Survey Area, resulting in an unapportioned mean abundance estimate of 3,093 [1,372; 4,896] and an apportioned mean abundance estimate of 3,094 [1,245; 5,384] individuals. Both equated to a mean density estimate of 5.55birds/km$^2$.

Temporal patterns of kittiwake abundance in Caledonia North Survey Area varied considerably between the 2021 and 2022 breeding seasons. In 2021, low mean apportioned abundances of kittiwake occurred in every month with the exception of July, when an obvious peak occurred within Caledonia North Survey Area. Both Caledonia North and Caledonia North plus 2 km buffer recorded a lesser peak in the same month. In the 2022 breeding season, the peak mean apportioned abundance of kittiwake was recorded in May 2022 across all reporting regions, which was also the peak breeding season count for kittiwake in Caledonia North across the whole baseline survey programme. Mean apportioned kittiwake abundance reduced month by month thereafter. Both April and August surveys within the survey period recorded low mean apportioned abundances of kittiwake. The temporal variation within Caledonia North Survey Area during both breeding seasons is somewhat different to that recorded for both Caledonia South Survey Area, and the Survey Area as a whole.

Reductions in mean apportioned abundance in the eight breeding season surveys outside the peak survey month varied from 1% to 99%, with most surveys falling towards the upper extent of this range. This indicates that the mean apportioned abundances were highly variable throughout the breeding season surveys when compared with the peak mean apportioned abundance for the baseline survey period, with many of the surveys recording apportioned mean kittiwake abundances considerably lower than the peak mean apportioned abundance.

During both years of surveys, kittiwake abundance was the lowest during the non-breeding season (September to March) with a wintering peak of abundance in November 2021 (Table 24, Figure 3):

- 64 individuals were recorded in Caledonia North, resulting in an unapportioned mean abundance estimate of 374 [216; 608] and an apportioned mean abundance estimate of 375 [205; 602] individuals. These equated to mean density estimates of 1.71 (unapportioned) and 1.72 (apportioned) birds/km$^2$.
- 96 individuals were recorded in Caledonia North plus 2 km buffer, resulting in an unapportioned mean abundance estimate of 548 [319; 804] and an apportioned mean abundance estimate of 548 [308; 850] individuals. Both equated to a mean density estimate of 1.46 birds/km$^2$.
- 138 individuals were recorded in Caledonia North Survey Area, resulting in an unapportioned mean abundance estimate of 806 [531; 1,133] and an apportioned mean abundance estimate of 806 [498; 1,180] individuals. Both equated to a mean density estimate of 1.45 birds/km$^2$.

During the two non-breeding seasons covered by the baseline surveys, the trends observed in apportioned mean kittiwake abundance were characterised by relatively consistent and low apportioned mean abundances across all reporting regions within Caledonia North Survey Area. Apportioned mean abundances were lowest in the winter months across both survey years, with peak mean apportioned abundances occurring in the autumn. Most of the 13 surveys in the non-breeding season, other than the peak month (November 2021), reported considerably lower mean apportioned abundances of birds than the peak month. Reductions in mean apportioned abundance relative to the peak were between 62% to 98%, with most surveys reporting reductions closer to the upper limit. This indicates that the mean apportioned abundances were somewhat variable throughout the breeding season surveys when compared with the peak mean apportioned abundance for the baseline survey period.

Good measures of precisions were calculated for most survey months (CV ≤ 0.16; Table 24). This was particularly the case for months during the breeding season (April to August), which is when the majority of records were made (Table 24). Within Caledonia North, four out of ten surveys carried out during the breeding season had a precision value of CV ≤ 0.16, with a further three surveys reporting a precision value of ≤ 0.2 (Table 24). Outside the breeding season, CV values of 0.2 to 0.5 for Caledonia North were more common (Table 24). For Caldonia North plus buffer regions, CV values were generally lower than the corresponding CV values for Caledonia North, indicating higher precision within these reporting regions (Table 24). The precision values for Caledonia North were generally higher than the equivalent values for Caledonia OWF, which is likely a product of a reduced number of records, coupled with lower transect numbers and lengths within these reporting regions relative to Caledonia OWF (Table 1, Table 23, Table 24). Despite this, confidence in the kittiwake abundance and density estimates for Caledonia North and Caledonia North plus buffers generated from the baseline survey data is still considered to be reasonably good, particularly for abundance and densities recorded during the breeding season (Table 24).

**Table 24 Raw counts, unapportioned and apportioned abundance and density estimates (birds per km$^2$) of kittiwakes in Caledonia North, Caledonia North plus 2 km buffer and Caledonia North Survey Area during the May 2021 to April 2023 survey period. Colour gradients follow the ascending order of kittiwake raw counts per season, with light yellow to orange (peak number) for the breeding season months (April to August) and light blue to royal blue (peak number) for the wintering months (September to March)**

| Survey | Raw count | Total unapportioned | | | | | Total apportioned | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Abundance | LCL | UCL | Precision (CV) | Density (km$^2$) | Abundance | LCL | UCL | Density (km$^2$) |
| a) Caledonia North | | | | | | | | | | |
| May-21 | 48 | 280 | 128 | 484 | 0.14 | 1.28 | 280 | 97 | 536 | 1.28 |
| Jun-21 | 21 | 124 | 47 | 219 | 0.22 | 0.57 | 124 | 41 | 219 | 0.57 |
| Jul-21 | 42 | 249 | 107 | 403 | 0.15 | 1.14 | 254 | 69 | 515 | 1.16 |
| Aug-21 | 24 | 139 | 81 | 197 | 0.20 | 0.64 | 139 | 66 | 214 | 0.64 |
| Sep-21 | 5 | 29 | 5 | 58 | 0.45 | 0.13 | 29 | 6 | 58 | 0.13 |
| Oct-21 | 17 | 99 | 23 | 193 | 0.24 | 0.45 | 99 | 24 | 199 | 0.45 |
| Nov-21 | 64 | 374 | 216 | 608 | 0.13 | 1.71 | 375 | 205 | 602 | 1.72 |
| Dec-21 | 5 | 29 | 6 | 64 | 0.45 | 0.13 | 29 | 5 | 64 | 0.13 |
| Jan-22 | 5 | 29 | 12 | 52 | 0.45 | 0.13 | 29 | 12 | 52 | 0.13 |
| Feb-22 | 9 | 48 | 11 | 102 | 0.33 | 0.22 | 49 | 10 | 102 | 0.22 |
| Mar-22 | 11 | 59 | 16 | 117 | 0.30 | 0.27 | 59 | 18 | 123 | 0.27 |
| Apr-22 | 14 | 80 | 34 | 138 | 0.27 | 0.37 | 81 | 35 | 143 | 0.37 |
| May-22 | 188 | 1,091 | 337 | 1,805 | 0.07 | 5.00 | 1,091 | 383 | 1,857 | 4.99 |
| Jun-22 | 92 | 524 | 131 | 1,219 | 0.10 | 2.40 | 524 | 134 | 1,219 | 2.40 |
| Jul-22 | 29 | 170 | 76 | 263 | 0.19 | 0.78 | 170 | 77 | 281 | 0.78 |
| Aug-22 | 29 | 167 | 81 | 265 | 0.19 | 0.76 | 167 | 81 | 271 | 0.76 |

| Survey | Raw count | Total unapportioned | | | | | Total apportioned | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Abundance | LCL | UCL | Precision (CV) | Density (km²) | Abundance | LCL | UCL | Density (km²) |
| Sep-22 | 10 | 57 | 11 | 138 | 0.32 | 0.26 | 57 | 11 | 138 | 0.26 |
| Oct-22 | 2 | 12 | 2 | 23 | 0.71 | 0.05 | 12 | 2 | 34 | 0.05 |
| Nov-22 | 6 | 35 | 6 | 83 | 0.41 | 0.16 | 36 | 8 | 82 | 0.16 |
| Jan-23 | 1 | 6 | 1 | 17 | 1.00 | 0.03 | 6 | 1 | 17 | 0.03 |
| Feb-23 | 8 | 46 | 8 | 115 | 0.35 | 0.21 | 46 | 8 | 115 | 0.21 |
| Mar-23 | 2 | 12 | 2 | 29 | 0.71 | 0.05 | 12 | 2 | 36 | 0.05 |
| Apr-23 | 7 | 39 | 11 | 73 | 0.38 | 0.18 | 39 | 11 | 73 | 0.18 |
| b) Caledonia North plus 2 km buffer | | | | | | | | | | |
| May-21 | 62 | 355 | 160 | 583 | 0.13 | 0.95 | 354 | 149 | 658 | 0.94 |
| Jun-21 | 38 | 220 | 98 | 388 | 0.16 | 0.59 | 220 | 89 | 417 | 0.59 |
| Jul-21 | 172 | 992 | 242 | 2,283 | 0.08 | 2.64 | 997 | 256 | 2,358 | 2.65 |
| Aug-21 | 52 | 295 | 221 | 391 | 0.14 | 0.79 | 295 | 218 | 397 | 0.79 |
| Sep-21 | 13 | 74 | 23 | 125 | 0.28 | 0.20 | 74 | 28 | 131 | 0.20 |
| Oct-21 | 35 | 200 | 97 | 320 | 0.17 | 0.53 | 200 | 90 | 326 | 0.53 |
| Nov-21 | 96 | 548 | 319 | 804 | 0.10 | 1.46 | 548 | 308 | 850 | 1.46 |
| Dec-21 | 16 | 91 | 45 | 142 | 0.25 | 0.24 | 91 | 41 | 142 | 0.24 |
| Jan-22 | 5 | 28 | 6 | 51 | 0.45 | 0.07 | 28 | 6 | 51 | 0.07 |
| Feb-22 | 17 | 91 | 38 | 150 | 0.24 | 0.24 | 94 | 33 | 163 | 0.25 |
| Mar-22 | 14 | 74 | 21 | 143 | 0.27 | 0.20 | 75 | 23 | 149 | 0.20 |
| Apr-22 | 23 | 129 | 56 | 202 | 0.21 | 0.34 | 130 | 57 | 214 | 0.35 |
| May-22 | 465 | 2,648 | 1,196 | 4,134 | 0.05 | 7.06 | 2,648 | 1,065 | 4,584 | 7.05 |
| Jun-22 | 171 | 986 | 340 | 1,886 | 0.08 | 2.63 | 987 | 353 | 2,111 | 2.63 |
| Jul-22 | 85 | 487 | 303 | 715 | 0.11 | 1.30 | 487 | 293 | 738 | 1.30 |
| Aug-22 | 51 | 292 | 154 | 440 | 0.14 | 0.78 | 291 | 151 | 452 | 0.77 |
| Sep-22 | 16 | 93 | 29 | 174 | 0.25 | 0.25 | 93 | 30 | 185 | 0.25 |
| Oct-22 | 3 | 18 | 6 | 35 | 0.58 | 0.05 | 18 | 3 | 47 | 0.05 |
| Nov-22 | 11 | 63 | 11 | 138 | 0.30 | 0.17 | 63 | 11 | 150 | 0.17 |
| Dec-22 | 2 | 12 | 2 | 35 | 0.71 | 0.03 | 14 | 2 | 41 | 0.04 |
| Jan-23 | 2 | 12 | 2 | 23 | 0.71 | 0.03 | 12 | 2 | 29 | 0.03 |
| Feb-23 | 10 | 57 | 11 | 131 | 0.32 | 0.15 | 57 | 10 | 143 | 0.15 |
| Mar-23 | 6 | 35 | 12 | 58 | 0.41 | 0.09 | 34 | 9 | 70 | 0.09 |
| Apr-23 | 9 | 51 | 17 | 86 | 0.33 | 0.14 | 51 | 17 | 86 | 0.14 |
| c) Caledonia North Survey Area | | | | | | | | | | |
| May-21 | 81 | 474 | 269 | 743 | 0.11 | 0.85 | 474 | 241 | 767 | 0.85 |
| Jun-21 | 81 | 479 | 195 | 810 | 0.11 | 0.86 | 479 | 186 | 810 | 0.86 |
| Jul-21 | 513 | 3,107 | 563 | 6,504 | 0.04 | 5.58 | 3,113 | 849 | 6,182 | 5.58 |
| Aug-21 | 75 | 435 | 325 | 569 | 0.12 | 0.78 | 447 | 298 | 615 | 0.80 |
| Sep-21 | 15 | 88 | 35 | 146 | 0.26 | 0.16 | 88 | 36 | 158 | 0.16 |
| Oct-21 | 52 | 304 | 129 | 508 | 0.14 | 0.55 | 304 | 134 | 502 | 0.55 |
| Nov-21 | 138 | 806 | 531 | 1,133 | 0.09 | 1.45 | 806 | 498 | 1,180 | 1.45 |
| Dec-21 | 18 | 105 | 47 | 169 | 0.24 | 0.19 | 105 | 48 | 168 | 0.19 |
| Jan-22 | 7 | 41 | 12 | 69 | 0.38 | 0.07 | 41 | 12 | 69 | 0.07 |
| Feb-22 | 21 | 116 | 61 | 176 | 0.22 | 0.21 | 119 | 56 | 206 | 0.21 |
| Mar-22 | 35 | 189 | 86 | 302 | 0.17 | 0.34 | 189 | 81 | 318 | 0.34 |
| Apr-22 | 35 | 201 | 115 | 282 | 0.17 | 0.36 | 202 | 122 | 288 | 0.36 |
| May-22 | 532 | 3,093 | 1,372 | 4,896 | 0.04 | 5.55 | 3,094 | 1,245 | 5,384 | 5.55 |
| Jun-22 | 300 | 1,734 | 901 | 2,658 | 0.06 | 3.11 | 1,733 | 735 | 3,028 | 3.11 |
| Jul-22 | 317 | 1,855 | 562 | 4,173 | 0.06 | 3.33 | 1,855 | 618 | 4,191 | 3.33 |
| Aug-22 | 73 | 418 | 235 | 618 | 0.12 | 0.75 | 418 | 204 | 687 | 0.75 |
| Sep-22 | 22 | 128 | 52 | 215 | 0.21 | 0.23 | 128 | 37 | 233 | 0.23 |
| Oct-22 | 4 | 23 | 6 | 41 | 0.50 | 0.04 | 24 | 4 | 53 | 0.04 |

| Survey | Raw count | Total unapportioned | | | | | Total apportioned | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Abundance | LCL | UCL | Precision (CV) | Density ($km^2$) | Abundance | LCL | UCL | Density ($km^2$) |
| **Nov-22** | 13 | 77 | 13 | 177 | 0.28 | 0.14 | 77 | 13 | 178 | 0.14 |
| **Dec-22** | 5 | 29 | 5 | 71 | 0.45 | 0.05 | 31 | 5 | 86 | 0.06 |
| **Jan-23** | 4 | 24 | 4 | 47 | 0.50 | 0.04 | 24 | 4 | 47 | 0.04 |
| **Feb-23** | 15 | 87 | 29 | 162 | 0.26 | 0.16 | 87 | 27 | 174 | 0.16 |
| **Mar-23** | 8 | 47 | 18 | 88 | 0.35 | 0.08 | 48 | 9 | 97 | 0.09 |
| **Apr-23** | 9 | 52 | 17 | 92 | 0.33 | 0.09 | 52 | 17 | 92 | 0.09 |

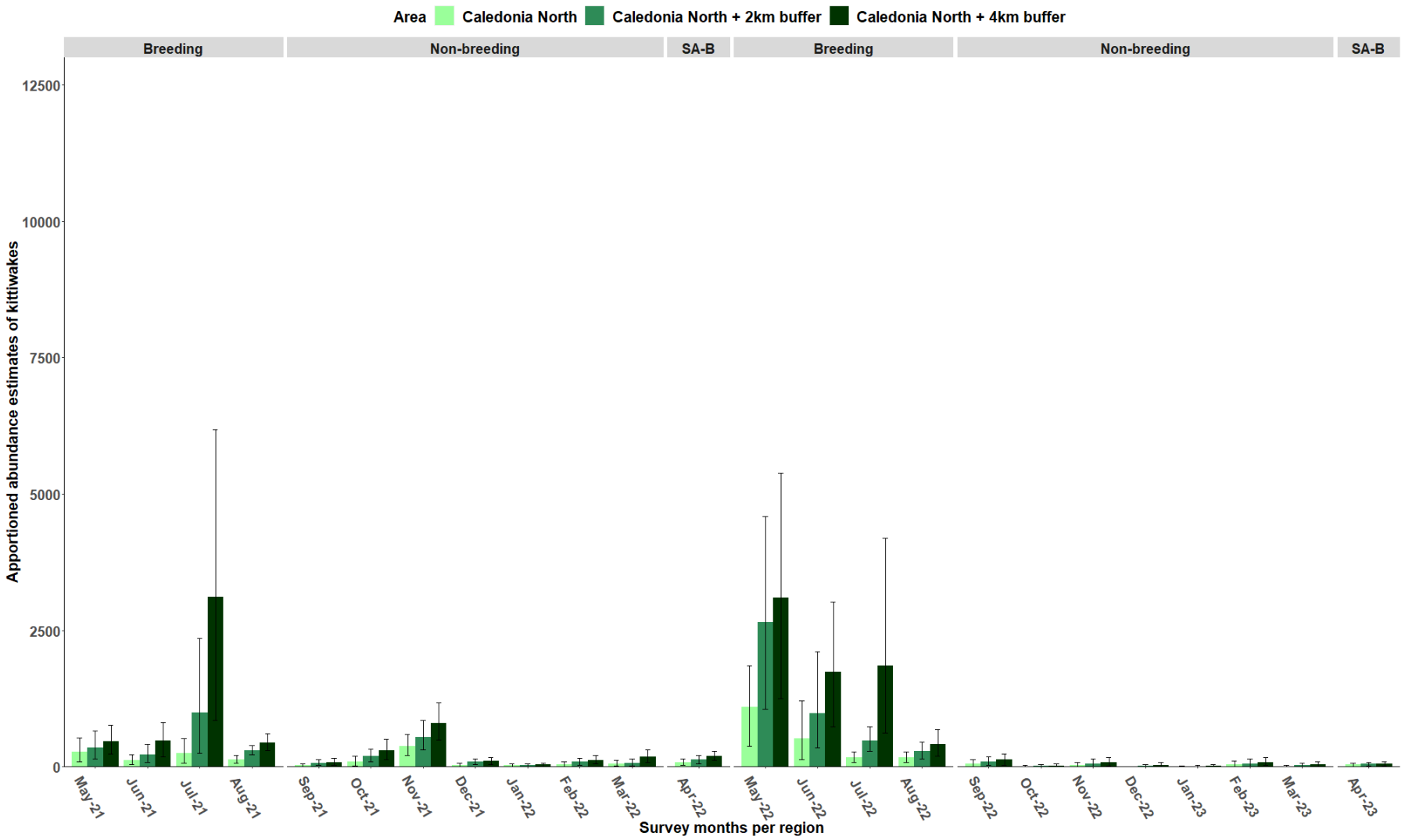



**Figure 3 Bar plot of monthly apportioned abundance estimates (with 95% confidence intervals) of the total kittiwakes recorded in each reporting region of Caledonia North Survey Area, during the May 2021 to April 2023 survey period. Kittiwake seasonal periods are also displayed. SA-B corresponds to month split between breeding site attendance (SA) and breeding (B)**

### *Caledonia South*

A total of 4,049 kittiwakes were recorded in Caledonia South Survey Area during both years of baseline surveys (Table 10). Kittiwakes were recorded in every survey (Table 25). Kittiwakes were the most abundant during kittiwake breeding season, with a peak of abundance in June 2022 in Caledonia South and Caledonia South plus 2 km buffer, and in July 2022 in Caledonia South Survey Area (Table 25, Figure 4):

- 410 individuals were recorded in Caledonia South in June 2022, resulting in an unapportioned mean abundance estimate of 2,375 [1,071; 4,089] and an apportioned mean abundance estimate of 2,375 [718; 4,732] individuals. Both equated to a mean density estimate of 11.29 birds/km$^2$.
- 615 individuals were recorded in Caledonia South plus 2 km buffer in June 2022, resulting in an unapportioned mean abundance estimate of 3,491 [1,686; 5,484] and an apportioned mean abundance estimate of 3,492 [1,113; 6,359] individuals. Both equated to a mean density estimate of 9.71 birds/km$^2$.
- 861 individuals were recorded in Caledonia South Survey Area in July 2022, resulting in an unapportioned mean abundance estimate of 4,985 [1,233; 9,628] and an apportioned mean abundance estimate of 4,985 [1,439; 9,755] individuals. These equated to mean density estimates of 9.35 (unapportioned) and 9.34 (apportioned) birds/km$^2$. However, in July 2021, the unapportioned and apportioned mean abundance estimates were higher with 5,146 [1,358-1,489; 9,542-10,148] individuals, which equated to mean density estimates of 9.65 (unapportioned) and 9.64 (apportioned) birds/km$^2$.

In both breeding seasons covered by the baseline surveys, apportioned mean kittiwake abundances across Caledonia South Survey Area grew steadily throughout the first half of the breeding season, with peaks observed in June or July depending on the reporting region and year in question. This is likely associated, at least in part, with breeding adult birds carrying out foraging trips from nearby breeding colonies. Mean apportioned abundances were considerably lower in August 2021 and 2022 than the preceding months. This would be expected since this is the time at which birds tend to leave the seas close to breeding colonies, in order to spend the non-breeding season in more oceanic areas.

Reductions in mean apportioned abundance in the breeding season surveys outside the peak survey month varied from 0% to 95%, with most surveys falling somewhere in the middle of the two extremes of this range. This indicates that the mean apportioned abundances were highly variable throughout the breeding season surveys when compared with the peak mean apportioned abundance for the baseline survey period.

During both years of surveys, kittiwake abundance was the lowest during the non-breeding season (September to March) with a wintering peak of abundance in October 2021 in Caledonia South and in September 2021 in Caledonia South plus buffers (Table 25; Figure 4):

- 18 individuals were recorded in Caledonia South in October 2021, resulting in an unapportioned mean abundance estimate of 105 [47; 187] and an apportioned mean abundance estimate of 106 [38; 199] individuals. Both equated to a mean density estimate of 0.50 birds/km$^2$.
- 122 individuals were recorded in Caledonia South plus 2 km buffer in September 2021, resulting in an unapportioned mean abundance estimate of 705 [122; 2,000] and an apportioned mean abundance estimate of 705 [122; 1,994] individuals. Both equated to a mean density estimate of 1.96 birds/km$^2$.
- 148 individuals were recorded Caledonia South Survey Area in September 2021, resulting in an unapportioned mean abundance estimate of 859 [148; 2,247] and an apportioned mean abundance estimate of 860 [170; 2,276] individuals. Both equated to a mean density estimate of 1.61 birds/km$^2$.

During the two non-breeding seasons covered by the baseline surveys, the trends observed in apportioned mean kittiwake abundance were characterised by relatively consistent and low apportioned mean abundances across all reporting regions within Caledonia South Survey Area. Apportioned mean abundances were lowest in the winter months across both survey years, with peak mean apportioned abundances occurring in the autumn. Most of the 13 surveys in the non-breeding season other than the peak month reported considerably lower mean apportioned abundances of birds than the peak month. Reductions in mean apportioned abundance relative to the peak were between 24% to 99%, with most surveys reporting reductions closer to the upper limit. This indicates that the mean apportioned abundances were quite variable throughout the breeding season surveys when compared with the peak mean apportioned abundance for the baseline survey period, with many of the surveys recording apportioned mean kittiwake abundances considerably lower than the peak mean apportioned abundance.

The 95% confidence intervals calculated for the mean abundances were often relatively high even for surveys where CV values were low (e.g. July 2021 and July 2022 for Caledonia South Survey Area). This is perhaps a consequence of the numbers of birds in single samples (i.e. images) being highly variable. Where reporting regions were smaller (e.g. Caledonia South), it is possible that there was lower variability between samples, resulting in tighter 95% confidence intervals about the mean abundance estimate.

Good measures of precisions were calculated for most survey months (CV ≤ 0.16; Table 25). This was particularly the case for months during the breeding season (April to August), which is when the majority of records were made (Table 25). Within Caledonia South, nine out of ten surveys carried out during the breeding season had a precision value of CV ≤ 0.16 (Table 25). Outside the breeding season, CV values of 0.2 to 0.5 for Caledonia South were more common, with small numbers of outliers (Table 25). For Caledonia South plus buffer regions, CV values were generally lower than the corresponding CV values for Caledonia South, indicating higher precision within these reporting regions (Table 25). The precision values for Caledonia South were generally higher (indicating lower precision) than the equivalent values for Caledonia OWF, which is likely a product of a reduced number of records, coupled with lower transect numbers and lengths within these reporting regions relative to Caledonia OWF (Table 1, Table 23, Table 25).

**Table 25 Raw counts, unapportioned and apportioned abundance and density estimates (birds per km$^2$) of kittiwakes in Caledonia South, Caledonia South plus 2 km buffer and Caledonia South Survey Area during the May 2021 to April 2023 survey period. Colour gradients follow the ascending order of kittiwake raw counts per season, with light yellow to orange (peak number) for the breeding season months (April to August) and light blue to royal blue (peak number) for the wintering months (September to March)**

| Survey | Raw count | Total unapportioned | | | | | Total apportioned | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Abundance | LCL | UCL | Precision (CV) | Density (km$^2$) | Abundance | LCL | UCL | Density (km$^2$) |
| a) Caledonia South | | | | | | | | | | |
| May-21 | 86 | 501 | 86 | 1,362 | 0.11 | 2.38 | 501 | 116 | 1,356 | 2.38 |
| Jun-21 | 154 | 896 | 268 | 2,018 | 0.08 | 4.26 | 896 | 308 | 2,105 | 4.26 |
| Jul-21 | 281 | 1,648 | 281 | 3,630 | 0.06 | 7.84 | 1,648 | 337 | 3,671 | 7.83 |
| Aug-21 | 38 | 219 | 104 | 352 | 0.16 | 1.04 | 220 | 94 | 393 | 1.05 |
| Sep-21 | 7 | 41 | 17 | 64 | 0.38 | 0.19 | 41 | 18 | 75 | 0.19 |
| Oct-21 | 18 | 105 | 47 | 187 | 0.24 | 0.50 | 106 | 38 | 199 | 0.50 |
| Nov-21 | 10 | 58 | 17 | 115 | 0.32 | 0.28 | 58 | 10 | 139 | 0.28 |
| Dec-21 | 5 | 29 | 6 | 52 | 0.45 | 0.14 | 29 | 7 | 63 | 0.14 |
| Jan-22 | 2 | 12 | 2 | 29 | 0.71 | 0.06 | 12 | 2 | 29 | 0.06 |
| Feb-22 | 6 | 32 | 11 | 54 | 0.41 | 0.15 | 32 | 8 | 64 | 0.15 |
| Mar-22 | 3 | 16 | 3 | 32 | 0.58 | 0.08 | 16 | 5 | 32 | 0.08 |

| Survey | Raw count | Total unapportioned | | | | | Total apportioned | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Abundance | LCL | UCL | Precision (CV) | Density (km²) | Abundance | LCL | UCL | Density (km²) |
| Apr-22 | 22 | 127 | 86 | 167 | 0.21 | 0.60 | 127 | 86 | 167 | 0.60 |
| May-22 | 138 | 797 | 138 | 1,900 | 0.09 | 3.79 | 797 | 179 | 1,900 | 3.79 |
| Jun-22 | 410 | 2,375 | 1,071 | 4,089 | 0.05 | 11.29 | 2,375 | 718 | 4,732 | 11.29 |
| Jul-22 | 173 | 1,009 | 239 | 2,438 | 0.08 | 4.80 | 1,009 | 272 | 2,391 | 4.79 |
| Aug-22 | 47 | 270 | 132 | 426 | 0.15 | 1.28 | 275 | 128 | 435 | 1.31 |
| Sep-22 | 14 | 82 | 41 | 122 | 0.27 | 0.39 | 81 | 22 | 169 | 0.38 |
| Oct-22 | 7 | 41 | 7 | 88 | 0.38 | 0.19 | 41 | 14 | 88 | 0.19 |
| Nov-22 | 4 | 23 | 4 | 70 | 0.50 | 0.11 | 24 | 4 | 71 | 0.12 |
| Dec-22 | 2 | 12 | 2 | 35 | 0.71 | 0.06 | 14 | 2 | 42 | 0.07 |
| Jan-23 | 1 | 6 | 1 | 18 | 1.00 | 0.03 | 6 | 1 | 18 | 0.03 |
| Feb-23 | 6 | 34 | 17 | 57 | 0.41 | 0.16 | 34 | 8 | 63 | 0.16 |
| Mar-23 | 2 | 12 | 2 | 23 | 0.71 | 0.06 | 12 | 2 | 29 | 0.06 |
| Apr-23 | 107 | 609 | 107 | 1,678 | 0.10 | 2.90 | 608 | 107 | 1,683 | 2.89 |
| b) | Caledonia South plus 2 km buffer | | | | | | | | | |
| May-21 | 111 | 641 | 150 | 1,520 | 0.09 | 1.78 | 648 | 195 | 1,589 | 1.80 |
| Jun-21 | 239 | 1,386 | 476 | 2,743 | 0.06 | 3.86 | 1,386 | 514 | 2,859 | 3.85 |
| Jul-21 | 598 | 3,479 | 599 | 7,529 | 0.04 | 9.68 | 3,480 | 676 | 7,488 | 9.67 |
| Aug-21 | 121 | 694 | 264 | 1,370 | 0.09 | 1.93 | 694 | 235 | 1,359 | 1.93 |
| Sep-21 | 122 | 705 | 122 | 2,000 | 0.09 | 1.96 | 705 | 122 | 1,994 | 1.96 |
| Oct-21 | 28 | 162 | 93 | 249 | 0.19 | 0.45 | 162 | 90 | 272 | 0.45 |
| Nov-21 | 31 | 177 | 74 | 298 | 0.18 | 0.49 | 177 | 77 | 304 | 0.49 |
| Dec-21 | 10 | 58 | 17 | 109 | 0.32 | 0.16 | 58 | 13 | 121 | 0.16 |
| Jan-22 | 2 | 11 | 2 | 29 | 0.71 | 0.03 | 11 | 2 | 29 | 0.03 |
| Feb-22 | 6 | 32 | 11 | 53 | 0.41 | 0.09 | 32 | 8 | 64 | 0.09 |
| Mar-22 | 8 | 42 | 21 | 69 | 0.35 | 0.12 | 42 | 17 | 79 | 0.12 |
| Apr-22 | 72 | 412 | 120 | 921 | 0.12 | 1.15 | 412 | 154 | 933 | 1.15 |
| May-22 | 202 | 1,159 | 258 | 2,358 | 0.07 | 3.22 | 1,159 | 303 | 2,444 | 3.22 |
| Jun-22 | 615 | 3,491 | 1,686 | 5,484 | 0.04 | 9.71 | 3,492 | 1,113 | 6,359 | 9.71 |
| Jul-22 | 285 | 1,649 | 602 | 3,252 | 0.06 | 4.59 | 1,649 | 583 | 3,402 | 4.58 |
| Aug-22 | 71 | 406 | 223 | 600 | 0.12 | 1.13 | 411 | 222 | 638 | 1.14 |
| Sep-22 | 26 | 149 | 80 | 217 | 0.20 | 0.41 | 149 | 45 | 292 | 0.41 |
| Oct-22 | 24 | 138 | 58 | 242 | 0.20 | 0.38 | 138 | 50 | 254 | 0.38 |
| Nov-22 | 9 | 52 | 9 | 122 | 0.33 | 0.14 | 52 | 9 | 125 | 0.15 |
| Dec-22 | 4 | 23 | 4 | 58 | 0.50 | 0.06 | 25 | 6 | 68 | 0.07 |
| Jan-23 | 1 | 6 | 1 | 17 | 1.00 | 0.02 | 6 | 1 | 17 | 0.02 |
| Feb-23 | 10 | 57 | 29 | 91 | 0.32 | 0.16 | 57 | 20 | 97 | 0.16 |
| Mar-23 | 7 | 40 | 7 | 81 | 0.38 | 0.11 | 41 | 10 | 83 | 0.11 |
| Apr-23 | 115 | 644 | 115 | 1,697 | 0.09 | 1.79 | 644 | 115 | 1,703 | 1.79 |
| c) | Caledonia South Survey Area | | | | | | | | | |
| May-21 | 139 | 806 | 249 | 1,706 | 0.08 | 1.51 | 812 | 273 | 1,838 | 1.52 |
| Jun-21 | 312 | 1,813 | 570 | 3,807 | 0.06 | 3.40 | 1,814 | 635 | 3,743 | 3.40 |
| Jul-21 | 857 | 5,146 | 1,489 | 9,542 | 0.03 | 9.65 | 5,146 | 1,358 | 10,148 | 9.64 |
| Aug-21 | 247 | 1,421 | 454 | 2,703 | 0.06 | 2.66 | 1,427 | 462 | 2,858 | 2.67 |
| Sep-21 | 148 | 859 | 148 | 2,247 | 0.08 | 1.61 | 860 | 170 | 2,276 | 1.61 |
| Oct-21 | 46 | 267 | 180 | 366 | 0.15 | 0.50 | 267 | 168 | 371 | 0.50 |
| Nov-21 | 61 | 351 | 178 | 512 | 0.13 | 0.66 | 351 | 166 | 529 | 0.66 |
| Dec-21 | 17 | 98 | 40 | 168 | 0.24 | 0.18 | 99 | 37 | 174 | 0.19 |
| Jan-22 | 4 | 23 | 6 | 40 | 0.50 | 0.04 | 23 | 6 | 40 | 0.04 |
| Feb-22 | 11 | 60 | 22 | 109 | 0.30 | 0.11 | 60 | 16 | 114 | 0.11 |
| Mar-22 | 15 | 81 | 43 | 113 | 0.26 | 0.15 | 81 | 34 | 134 | 0.15 |
| Apr-22 | 80 | 459 | 155 | 997 | 0.11 | 0.86 | 458 | 189 | 992 | 0.86 |

| Survey | Raw count | Total unapportioned | | | | | Total apportioned | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Abundance | LCL | UCL | Precision (CV) | Density ($km^2$) | Abundance | LCL | UCL | Density ($km^2$) |
| **May-22** | 236 | 1,356 | 385 | 2,857 | 0.07 | 2.54 | 1,356 | 396 | 2,805 | 2.54 |
| **Jun-22** | 680 | 3,938 | 1,946 | 6,382 | 0.04 | 7.38 | 3,938 | 1,489 | 7,384 | 7.38 |
| **Jul-22** | **861** | **4,985** | **1,233** | **9,628** | **0.03** | **9.35** | **4,985** | **1,439** | **9,755** | **9.34** |
| **Aug-22** | 92 | 527 | 287 | 797 | 0.10 | 0.99 | 533 | 288 | 824 | 1.00 |
| **Sep-22** | 35 | 204 | 128 | 280 | 0.17 | 0.38 | 204 | 82 | 362 | 0.38 |
| **Oct-22** | 31 | 182 | 88 | 294 | 0.18 | 0.34 | 182 | 81 | 323 | 0.34 |
| **Nov-22** | 13 | 76 | 13 | 170 | 0.28 | 0.14 | 76 | 13 | 165 | 0.14 |
| **Dec-22** | 5 | 29 | 5 | 65 | 0.45 | 0.05 | 32 | 5 | 76 | 0.06 |
| **Jan-23** | 2 | 12 | 2 | 29 | 0.71 | 0.02 | 12 | 2 | 29 | 0.02 |
| **Feb-23** | 21 | 121 | 58 | 196 | 0.22 | 0.23 | 121 | 41 | 231 | 0.23 |
| **Mar-23** | 13 | 76 | 35 | 122 | 0.28 | 0.14 | 77 | 23 | 132 | 0.14 |
| **Apr-23** | 123 | 704 | 123 | 1,803 | 0.09 | 1.32 | 705 | 123 | 1,798 | 1.32 |

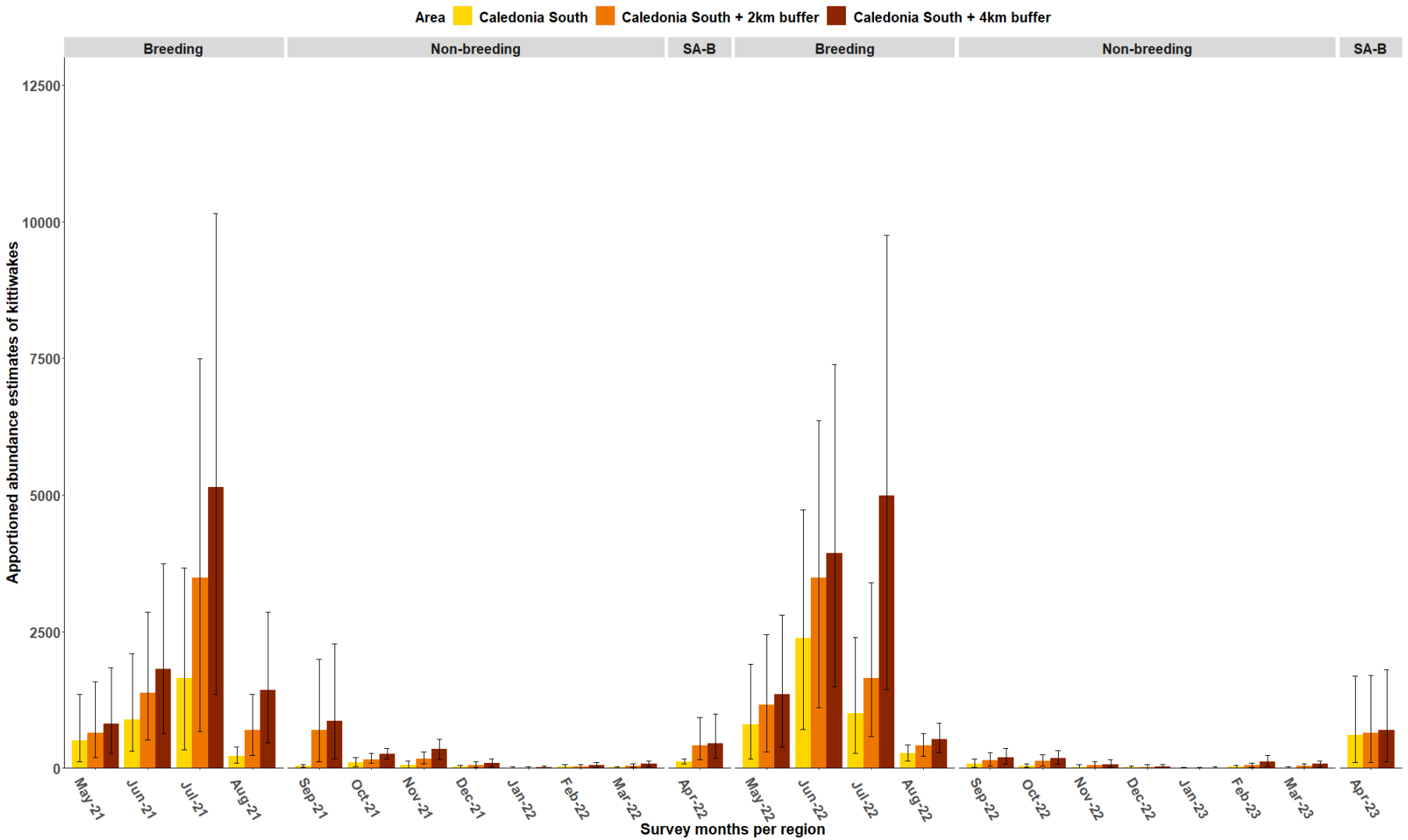



**Figure 4 Bar plot of monthly apportioned abundance estimates (with 95% confidence intervals) of the total kittiwakes recorded in each reporting region of Caledonia South Survey Area, during the May 2021 to April 2023 survey period. Kittiwake seasonal periods are also displayed. SA-B corresponds to month split between breeding site attendance (SA) and breeding (B)**

### *ii. Distribution and behaviour*

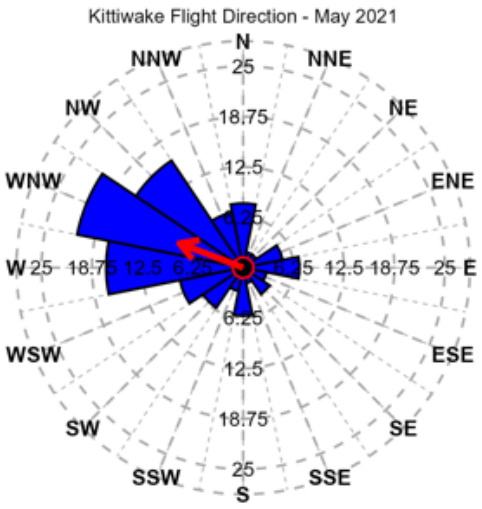
Maps of distribution are shown in Appendix 4: Figures A4.4-27. Kittiwakes were distributed throughout the Survey Area in May 2021 (Figure A4.4), October 2021 (Figure A4.9), December 2021 to June 2022 (Figure A4.11-17), August 2022 (Figure A4.19), and February 2023 (Figure A4.25). From June to September 2021, and in July and October 2022 and March 2023, their distribution was more concentrated in Caledonia South and Caledonia South Buffer Zone (Figure A4.5-8, 18, 21, 26). Most kittiwakes were recorded in the north and west of the Survey Area in November 2021 (Figure A4.10). In September 2022 and April 2023, kittiwakes were in the north and south of the Survey Area (Figure A4.20, 27). Most kittiwakes were recorded in the eastern side of the Survey Area near the subdivision line in November 2022 (Figure A4.22) and in the east of buffer and southwest corner of Caledonia South in December 2022 (Figure A4.23). In January 2023, they were recorded in the north of Caledonia North Buffer Zone, in the south of Caledonia North and in the south of Caledonia South (Figure A4.24).

Based on the location of key breeding colonies relative to Caledonia OWF, it could be inferred that the reason for the distribution that was observed during this period of the year was due to the presence of breeding adults from Troup, Pennan and Lion's Heads SPA, situated to the south of the Survey Area. However, it is recognised that there is potential connectivity between Caledonia OWF and other breeding kittiwake SPAs during the breeding season.

Significant predominant direction of flight was recorded in:

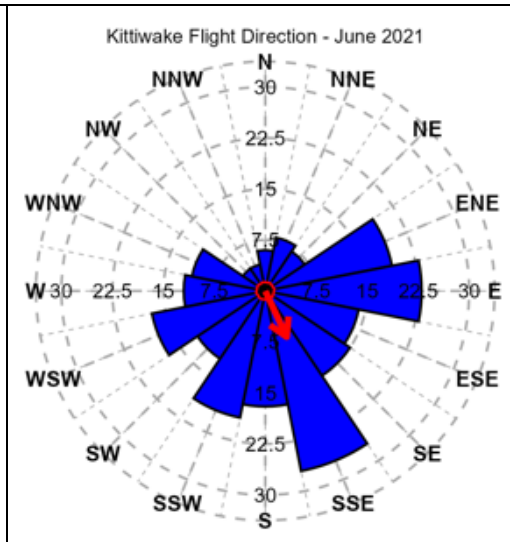
- **May**
  - 2021 west-northwest (Figure 5a)
  - 2022 west-southwest (Figure 5l)
- **June**
  - 2021 south-southeast (Figure 5b)
  - 2022 northeast (Figure 5m)
- **July**
  - 2021 south-southeast (Figure 5c)
  - 2022 south-southeast (Figure 5n)
- **August**
  - 2021 north-northwest (Figure 5d)
  - 2022 west-southwest (Figure 5o)
- **September**
  - 2021 west-southwest (Figure 5e)
  - 2022 west (Figure 5p)
- **October**
  - 2021 south-southwest (Figure 5f)
  - 2022 southwest (Figure 5q)
- **November**
  - 2021 southwest (Figure 5g)
  - 2022 south-southeast (Figure 5r)
- **December**
  - 2021 west-northwest (Figure 5h)
- **February**
  - 2023 east-southeast (Figure 5i)
- **March**
  - 2022 south-southeast (Figure 5j)
- **April**
  - 2022 east-southeast (Figure 5k)
  - 2023 south-southeast (Figure 5s)

As very few birds were recorded in flight in other surveys, they were too infrequent to determine any preference in flight direction (Appendix 5, Figure A5.4).



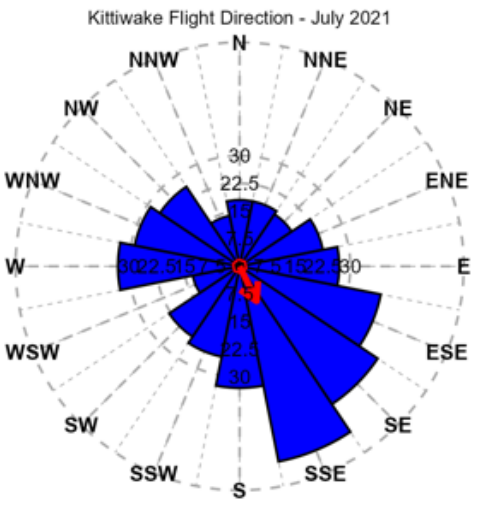

| | |
|---|---|
| Number of Observations | 117 |
| Mean Vector (μ) | 291.934 |
| Length of Mean Vector (r) | 0.402 |
| Rayleigh Test (Z) | 18.863 |
| Rayleigh Test (p) | <0.001 |

**a May 2021**



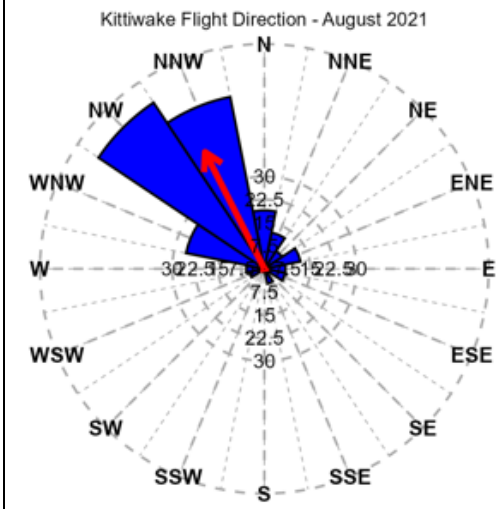

| | |
|---|---|
| Number of Observations | 215 |
| Mean Vector (μ) | 155.316 |
| Length of Mean Vector (r) | 0.276 |
| Rayleigh Test (Z) | 16.360 |
| Rayleigh Test (p) | <0.001 |

**b June 2021**



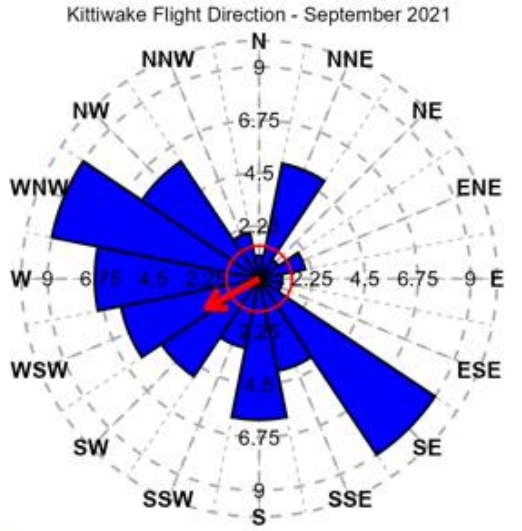

| | |
|---|---|
| Number of Observations | 437 |
| Mean Vector (μ) | 154.589 |
| Length of Mean Vector (r) | 0.194 |
| Rayleigh Test (Z) | 16.481 |
| Rayleigh Test (p) | <0.001 |

**c July 2021**



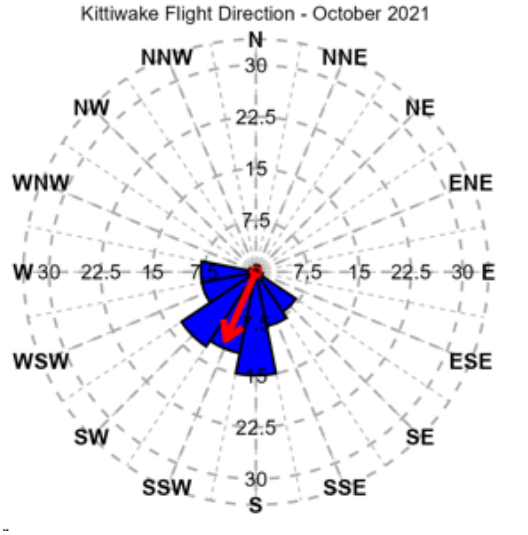

| | |
|---|---|
| Number of Observations | 232 |
| Mean Vector (μ) | 333.917 |
| Length of Mean Vector (r) | 0.655 |
| Rayleigh Test (Z) | 99.433 |
| Rayleigh Test (p) | <0.001 |

**d August 2021**



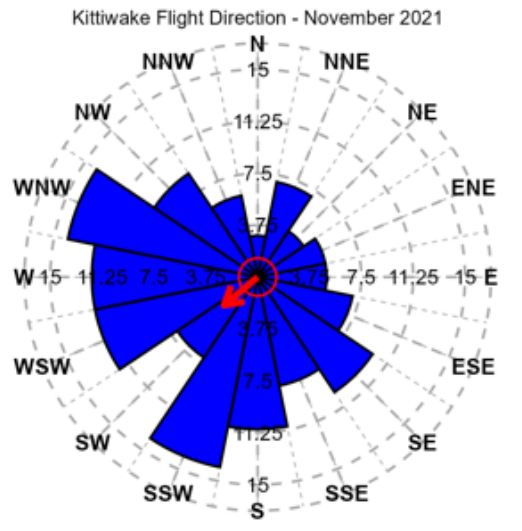

| | |
|---|---|
| Number of Observations | 68 |
| Mean Vector (μ) | 241.079 |
| Length of Mean Vector (r) | 0.282 |
| Rayleigh Test (Z) | 5.424 |
| Rayleigh Test (p) | 0.004 |

**e September 2021**



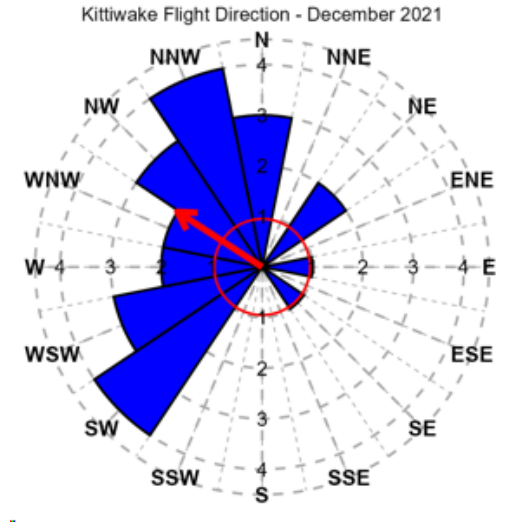

| | |
|---|---|
| Number of Observations | 75 |
| Mean Vector (μ) | 204.475 |
| Length of Mean Vector (r) | 0.717 |
| Rayleigh Test (Z) | 38.587 |
| Rayleigh Test (p) | <0.001 |

**f October 2021**



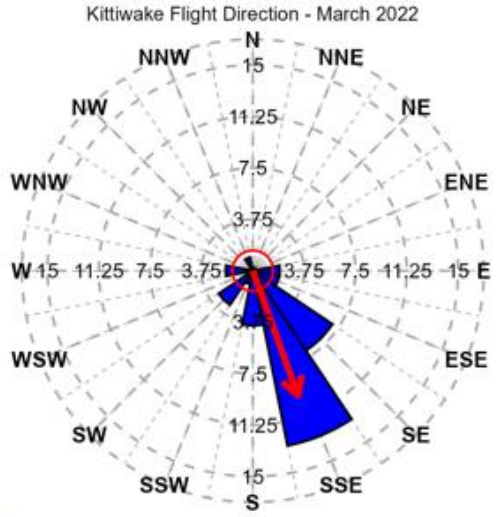

| | |
|---|---|
| Number of Observations | 134 |
| Mean Vector (μ) | 230.689 |
| Length of Mean Vector (r) | 0.227 |
| Rayleigh Test (Z) | 6.906 |
| Rayleigh Test (p) | 0.001 |

**g November 2021**



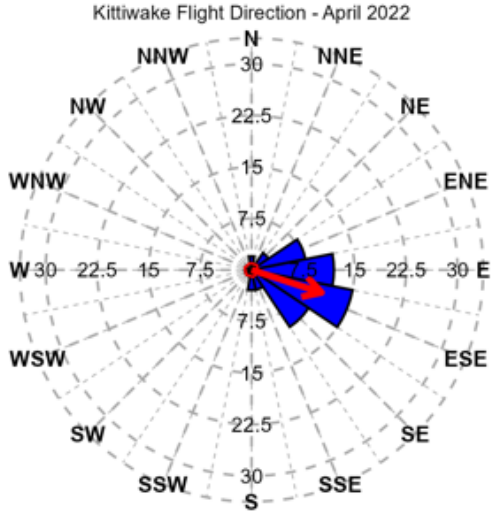

| | |
|---|---|
| Number of Observations | 25 |
| Mean Vector (μ) | 303.250 |
| Length of Mean Vector (r) | 0.501 |
| Rayleigh Test (Z) | 6.279 |
| Rayleigh Test (p) | 0.001 |

**h December 2021**



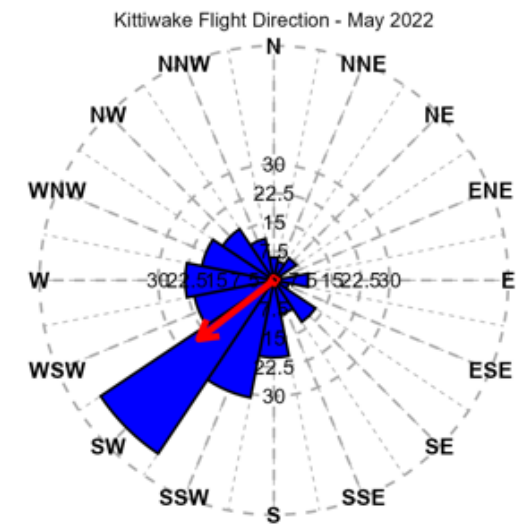

| | |
|---|---|
| Number of Observations | 35 |
| Mean Vector (μ) | 160.209 |
| Length of Mean Vector (r) | 0.743 |
| Rayleigh Test (Z) | 19.311 |
| Rayleigh Test (p) | <0.001 |

**i March 2022**



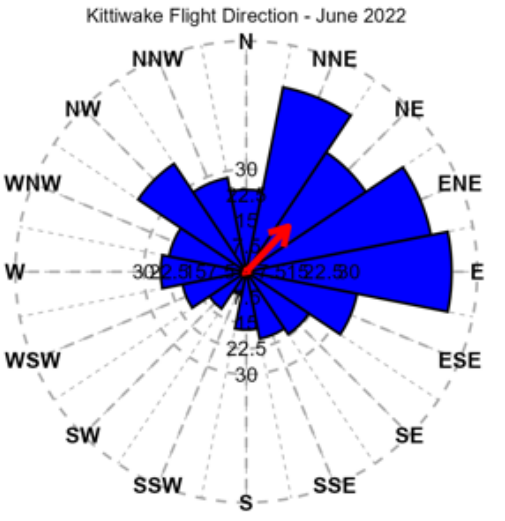

| | |
|---|---|
| Number of Observations | 60 |
| Mean Vector (μ) | 108.084 |
| Length of Mean Vector (r) | 0.714 |
| Rayleigh Test (Z) | 30.550 |
| Rayleigh Test (p) | <0.001 |

**j April 2022**



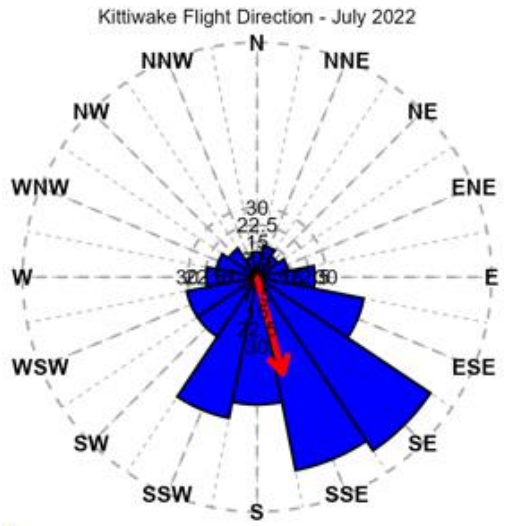

| | |
|---|---|
| Number of Observations | 250 |
| Mean Vector (μ) | 232.740 |
| Length of Mean Vector (r) | 0.458 |
| Rayleigh Test (Z) | 52.352 |
| Rayleigh Test (p) | <0.001 |

**k May 2022**



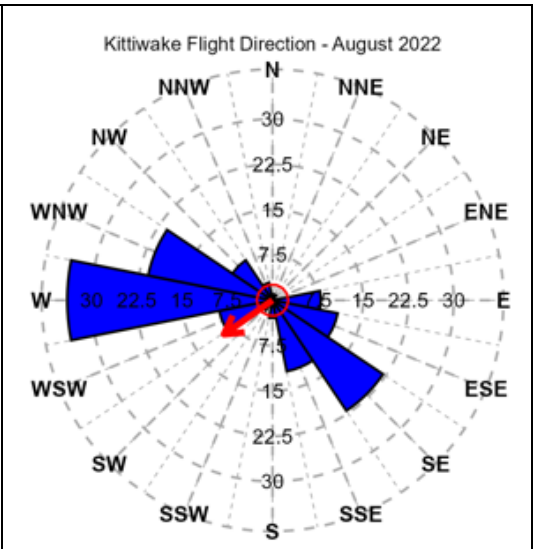

| | |
|---|---|
| Number of Observations | 481 |
| Mean Vector (μ) | 43.805 |
| Length of Mean Vector (r) | 0.299 |
| Rayleigh Test (Z) | 43.103 |
| Rayleigh Test (p) | <0.001 |

**l June 2022**



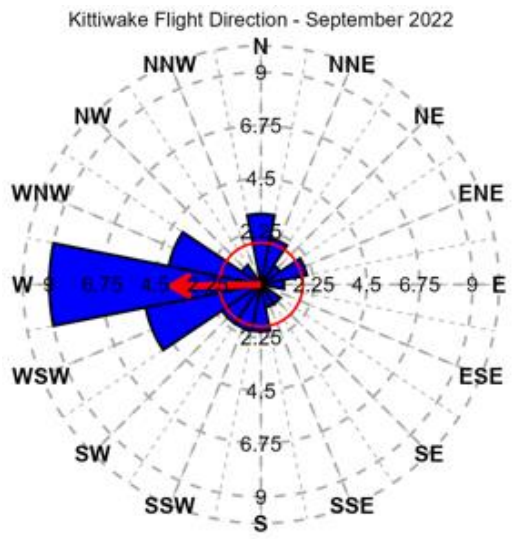

| | |
|---|---|
| Number of Observations | 540 |
| Mean Vector (μ) | 165.085 |
| Length of Mean Vector (r) | 0.477 |
| Rayleigh Test (Z) | 122.964 |
| Rayleigh Test (p) | <0.001 |

**m July 2022**



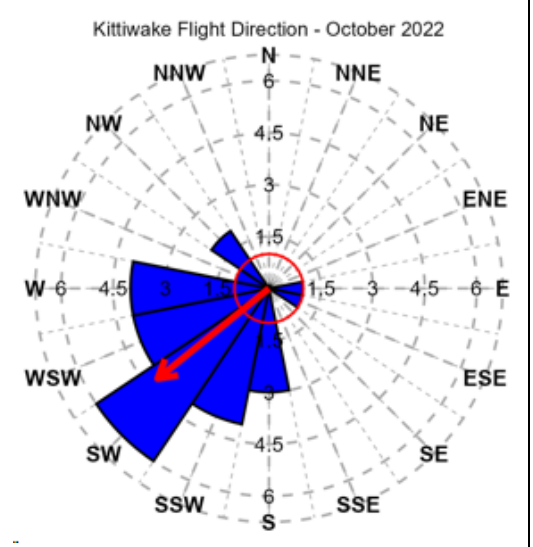

| | |
|---|---|
| Number of Observations | 135 |
| Mean Vector (μ) | 235.020 |
| Length of Mean Vector (r) | 0.288 |
| Rayleigh Test (Z) | 11.226 |
| Rayleigh Test (p) | <0.001 |

**n August 2022**



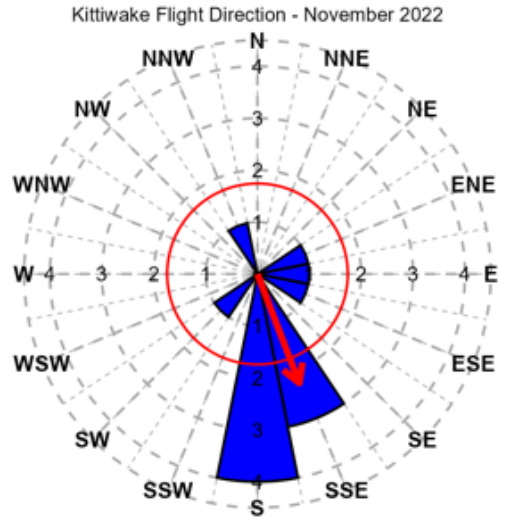

| | |
|---|---|
| Number of Observations | 36 |
| Mean Vector (μ) | 269.557 |
| Length of Mean Vector (r) | 0.418 |
| Rayleigh Test (Z) | 6.294 |
| Rayleigh Test (p) | 0.002 |

**o September 2022**



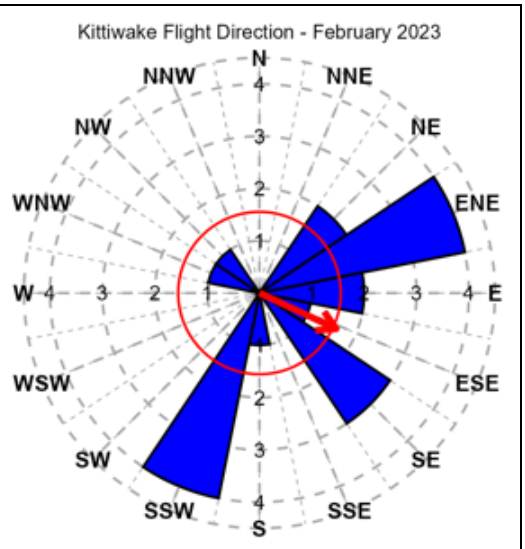

| | |
|---|---|
| Number of Observations | 26 |
| Mean Vector (μ) | 231.834 |
| Length of Mean Vector (r) | 0.690 |
| Rayleigh Test (Z) | 12.369 |
| Rayleigh Test (p) | <0.001 |

**p October 2022**



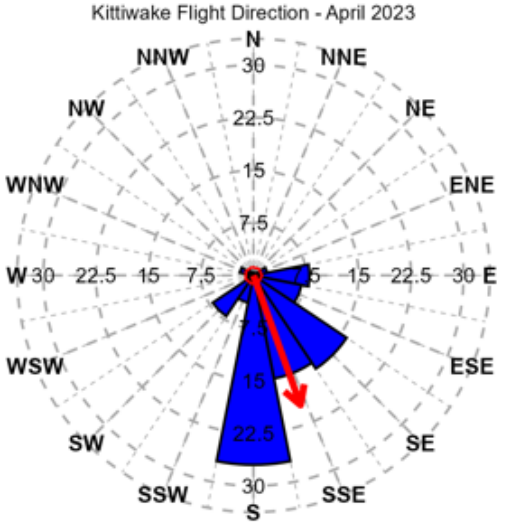

| | |
|---|---|
| Number of Observations | 12 |
| Mean Vector (μ) | 159.037 |
| Length of Mean Vector (r) | 0.563 |
| Rayleigh Test (Z) | 3.798 |
| Rayleigh Test (p) | 0.019 |

**q November 2022**




| | |
|---|---|
| Number of Observations | 19 |
| Mean Vector (μ) | 115.393 |
| Length of Mean Vector (r) | 0.404 |
| Rayleigh Test (Z) | 3.100 |
| Rayleigh Test (p) | 0.043 |

**r February 2023**




| | |
|---|---|
| Number of Observations | 91 |
| Mean Vector (μ) | 160.200 |
| Length of Mean Vector (r) | 0.728 |
| Rayleigh Test (Z) | 48.244 |
| Rayleigh Test (p) | <0.001 |

**s April 2023**

**Figure 5 Summary of flight direction of kittiwakes within surveys where a significant flight direction was recorded during the May 2021 to April 2023 survey period**

## 4.5 Common gull

### *i. Abundance and density estimates*

#### *Caledonia OWF*

A total of 13 common gulls were recorded in the Survey Area during both years of baseline surveys (Table 8). Common gulls were only recorded in August and December 2022 in Caledonia OWF both with two individuals, and subsequently low mean abundance and densities (Table 26). Eight common gulls were additionally recorded in September 2021 in Caledonia OWF plus 2 km (Table 26). This resulted in an estimated unapportioned and apportioned mean abundance of 46 [8, 115] individuals, which both equated to a mean density estimate of 0.07 birds/km$^2$ (Table 26).

In the Survey Area, common gulls were recorded in September, November 2021 and August and December 2022, with a peak of eight individuals in September 2021 (Table 26). This resulted in an estimated unapportioned and apportioned mean abundance of 47 [8, 129] individuals, which equated to a mean density estimate of 0.05 birds/km$^2$ (Table 26).

Common gulls were, therefore, mostly recorded during their non-breeding period (September to February), with only a couple of individuals recorded at the end of their breeding season (April to August). The baseline data indicates that the Survey Area is of limited importance to this species year round, but particularly during the breeding season.

Measures of precisions were high (indicating lower levels of precision), which is likely related to the low numbers of individuals recorded in each reporting region during each survey (CV > 0.16; Table 26).

**Table 26 Raw counts, unapportioned and apportioned abundance and density estimates (birds per km$^2$) of common gulls in Caledonia OWF, Caledonia OWF plus 2 km buffer and the Survey Area during the May 2021 to April 2023 survey period**

| Survey | Raw count | Total unapportioned | | | | | Total apportioned | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Abundance | LCL | UCL | Precision (CV) | Density (km$^2$) | Abundance | LCL | UCL | Density (km$^2$) |
| **a) Caledonia OWF** | | | | | | | | | | |
| **Aug-22** | 2 | 12 | 2 | 35 | 0.71 | 0.03 | 12 | 2 | 35 | 0.03 |
| **Dec-22** | 2 | 12 | 2 | 23 | 0.71 | 0.03 | 14 | 2 | 33 | 0.03 |
| **b) Caledonia OWF plus 2 km buffer** | | | | | | | | | | |
| **Sep-21** | 8 | 46 | 8 | 115 | 0.35 | 0.07 | 46 | 8 | 115 | 0.07 |
| **Aug-22** | 2 | 11 | 2 | 34 | 0.71 | 0.02 | 11 | 2 | 34 | 0.02 |
| **Dec-22** | 2 | 12 | 2 | 29 | 0.71 | 0.02 | 13 | 2 | 31 | 0.02 |
| **c) Survey Area** | | | | | | | | | | |
| **Sep-21** | 8 | 47 | 8 | 129 | 0.35 | 0.05 | 47 | 8 | 129 | 0.05 |
| **Nov-21** | 1 | 6 | 1 | 17 | 1.00 | 0.01 | 6 | 1 | 17 | 0.01 |
| **Aug-22** | 2 | 11 | 2 | 34 | 0.71 | 0.01 | 11 | 2 | 34 | 0.01 |
| **Dec-22** | 2 | 12 | 2 | 29 | 0.71 | 0.01 | 12 | 2 | 31 | 0.01 |

#### *Caledonia North*

A total of seven common gulls were recorded in Caledonia North Survey Area during both years of baseline surveys (Table 9). In Caledonia North, only three common gulls were recorded in August and December 2022, and subsequently low mean abundance and densities (Table 27). In Caledonia North plus 2 km buffer, two common gulls were additionally recorded in September 2021 (Table 27). This resulted in unapportioned and apportioned mean abundance estimate of 11 [2, 34] individuals, which both equated to a mean density estimate of 0.03 birds/km$^2$, in both September 2021 and August 2022 (Table 27).

In Caldonia North Survey Area, common gulls were recorded September, November 2021 and August and December 2022, with peaks in September 2021 and August 2022 (two individuals), resulting in an estimated unapportioned and apportioned mean abundance of 12 [2, 34-35] individuals. These equated to mean density estimates of 0.03 (unapportioned) and 0.02 (apportioned) birds/km$^2$ in both September 2021 and August 2022 (Table 27).

Common gulls were therefore mostly recorded during their non-breeding period, with the exception of August 2022. The baseline data indicates that the Caledonia North Survey Area is of limited importance to this species year-round, but particularly during the breeding season.

Measures of precisions were high (indicating lower levels of precision), which is likely related to the low numbers of individuals recorded in each reporting region during each survey (CV > 0.16; Table 27).

**Table 27 Raw counts, unapportioned and apportioned abundance and density estimates (birds per km$^2$) of common gulls in Caledonia North, Caledonia North plus 2 km buffer and Caledonia North Survey Area during the May 2021 to April 2023 survey period**

| Survey | Raw count | Total unapportioned | | | | | Total apportioned | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Abundance | LCL | UCL | Precision (CV) | Density (km$^2$) | Abundance | LCL | UCL | Density (km$^2$) |
| **a) Caledonia North** | | | | | | | | | | |
| **Aug-22** | 2 | 12 | 2 | 35 | 0.71 | 0.05 | 12 | 2 | 35 | 0.05 |
| **Dec-22** | 1 | 6 | 1 | 17 | 1.00 | 0.03 | 6 | 1 | 17 | 0.03 |
| **b) Caledonia North plus 2 km buffer** | | | | | | | | | | |
| **Sep-21** | 2 | 11 | 2 | 34 | 0.71 | 0.03 | 11 | 2 | 34 | 0.03 |
| **Aug-22** | 2 | 11 | 2 | 34 | 0.71 | 0.03 | 11 | 2 | 34 | 0.03 |
| **Dec-22** | 2 | 12 | 2 | 29 | 0.71 | 0.03 | 12 | 2 | 29 | 0.03 |
| **c) Caledonia North Survey Area** | | | | | | | | | | |
| **Sep-21** | 2 | 12 | 2 | 35 | 0.71 | 0.03 | 12 | 2 | 35 | 0.02 |
| **Nov-21** | 1 | 6 | 1 | 18 | 1.00 | 0.01 | 6 | 1 | 18 | 0.01 |
| **Aug-22** | 2 | 12 | 2 | 35 | 0.71 | 0.03 | 11 | 2 | 34 | 0.02 |
| **Dec-22** | 1 | 6 | 1 | 18 | 1.00 | 0.01 | 12 | 2 | 29 | 0.02 |

### *Caledonia South*

A total of nine common gulls were recorded in Caledonia South Survey Area during both years of baseline surveys (Table 10). In Caledonia South, a single common gull was recorded in December 2022 (Table 10), and subsequently very low abundance and densities. In Caledonia South plus 2 km buffer, six common gulls were additionally recorded in September 2021 (Table 28). This resulted in an unapportioned and apportioned mean abundance of 35 [6, 104] individuals, which both equated to a mean density estimate of 0.10 birds/km$^2$ (Table 28).

In Caledonia South Survey Area, common gulls were recorded in September 2021, August and December 2022, with a of six individuals in September 2021 (Table 28). This resulted in an unapportioned and apportioned mean abundance of 35 [6, 105] individuals, which both equated to a mean density estimate of 0.07 birds/km$^2$ (Table 28).

Common gulls were, therefore, mostly recorded during their non-breeding period, with the exception of August 2022. The baseline data indicates that the Survey Area is of limited importance to this species year-round, but particularly during the breeding season.

Measures of precisions were high (indicating lower levels of precision), which is likely related to the low numbers of individuals recorded in each reporting region during each survey (CV > 0.16; Table 28).

**Table 28 Raw counts, unapportioned and apportioned abundance and density estimates (birds per km$^2$) of common gulls in Caledonia South, Caledonia South plus 2 km buffer and Caledonia South Survey Area during the May 2021 to April 2023 survey period**

| Survey | Raw count | Total unapportioned | | | | | Total apportioned | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Abundance | LCL | UCL | Precision (CV) | Density (km$^2$) | Abundance | LCL | UCL | Density (km$^2$) |
| **a) Caledonia South** | | | | | | | | | | |
| **Dec-22** | 1 | 6 | 1 | 18 | 1.00 | 0.03 | 7 | 1 | 22 | 0.03 |
| **b) Caledonia South plus 2 km buffer** | | | | | | | | | | |
| **Sep-21** | 6 | 35 | 6 | 104 | 0.41 | 0.10 | 35 | 6 | 104 | 0.10 |
| **Dec-22** | 1 | 6 | 1 | 17 | 1.00 | 0.02 | 7 | 2 | 19 | 0.02 |
| **c) Caledonia South Survey Area** | | | | | | | | | | |
| **Sep-21** | 6 | 35 | 6 | 105 | 0.41 | 0.07 | 35 | 6 | 105 | 0.07 |
| **Aug-22** | 2 | 11 | 2 | 34 | 0.71 | 0.02 | 11 | 2 | 34 | 0.02 |
| **Dec-22** | 1 | 6 | 1 | 18 | 1.00 | 0.01 | 6 | 1 | 20 | 0.01 |

#### *ii. Distribution and behaviour*

Maps of distribution are shown in Appendix 4: Figures A4.28-32. In September 2021, common gulls were recorded in the west of Caledonia North Buffer Zone and the east of Caledonia South Buffer Zone (Figure A4.28). In November 2021, a single common gull was recorded in the northwest towards the outer Buffer Zone boundary of Caledonia North Survey Area (Figure A4.29). Common gulls were recorded in the centre of Caledonia North in May 2022 and in the south of Caledonia North in August 2022 (Figures A4.30-31). In December 2022, one common gull was recorded in the north of Caledonia North while a second individual was recorded in the north of Caledonia South, near the subdivision line with Caledonia North (Figure A4.32).

As very few birds were recorded in flight, they were too infrequent to determine any preference in flight direction (Appendix 5, Figure A5.5).

### 4.6 Great black-backed gull

#### *i. Abundance and density estimates*

##### *Caledonia OWF*

A total of 540 great black-backed gulls were recorded in the Survey Area during both years of baseline surveys (Table 8). Great black-backed gulls were most abundant during the non-breeding season (September to March) (Table 29, Figure 6). In Caledonia OWF, they were only recorded during this season, with the exception of August 2022 where an apportioned mean abundance of 1 [0, 3] individual was estimated (Table 29). In total, great black-backed gulls were recorded in 13, 17, and 17 of the 24 baseline surveys in Caledonia OWF, Caledonia OWF plus 2 km buffer, and the Survey Area, respectively. In August 2022 and April 2023, great black-backed gulls have been recorded after apportioning despite not being directly recorded during the relevant survey (Table 29). This represents apportioning of black-backed gulls and/or large gull species into the great black-backed gull category, following the hierarchy outlined in Section 3.5.

Peak numbers of great black-backed gull were recorded in November 2021 (Table 29, Figure 6):

- 73 individuals were recorded in Caledonia OWF, resulting in an unapportioned mean abundance estimate of 424 [197; 755] and an apportioned mean abundance estimate of 473 [189; 923] individuals. These equated to mean density estimates of 0.99 (unapportioned) and 1.11 (apportioned) birds/km$^2$.

- 119 individuals were recorded in Caledonia OWF plus 2 km buffer, resulting in an unapportioned mean abundance estimate of 681 [383; 1,058] and an apportioned mean abundance estimate of 760 [372; 1,294] individuals. These equated to mean density estimates of 1.06 (unapportioned) and 1.18 (apportioned) birds/km$^2$.
- 163 individuals were recorded in the Survey Area, resulting in an unapportioned mean abundance estimate of 949 [553; 1,444] and an apportioned mean abundance estimate of 1,046 [519; 1,745] individuals. These equated to mean density estimates of 1.07 (unapportioned) and 1.18 (apportioned) birds/km$^2$.

During the two non-breeding seasons covered by the baseline surveys, peak mean apportioned abundances of great black-backed gull within the Survey Area occurred in November 2021 and October 2022, with other months considerably lower in mean apportioned abundances than the overall peak for the two years of surveys (November 2021). In the 2021/22 non-breeding season, apportioned mean abundances were generally higher in the autumn than the winter period, with birds largely absent by the spring, presumably as birds move towards their breeding colonies. In the 2022/23 non-breeding season, mean apportioned abundances were comparable throughout most of the season. A key difference between the two non-breeding periods were the overall numbers of birds present, with the 2021/22 non-breeding season surveys recording larger numbers of birds than the 2022/23 non-breeding season surveys. Reductions in mean apportioned abundance relative to the peak were between 55% to 99%, with most surveys reporting reductions closer to the upper limit. This indicates that the mean apportioned abundances were somewhat variable throughout the breeding season surveys when compared with the peak mean apportioned abundance for the baseline survey period.

Great black-backed gulls were absent from Caledonia OWF during the breeding season (April to July) and in March during the breeding site attendance period (Table 29; Figure 6). However, low numbers of individuals (≤5) were recorded in both 2 km and 4 km Buffer Zones during the aforementioned periods (Table 29, Figure 6).

The 95% confidence intervals calculated for the mean abundances were sometimes relatively high even for surveys where CV values were low (e.g. September 2021 and November 2021 for the Survey Area). This is perhaps a consequence of the numbers of birds in single samples (i.e. images) being highly variable. Where reporting regions were smaller (e.g. Caledonia OWF), it is possible that there was lower variability between samples, resulting in tighter 95% confidence intervals about the mean abundance estimate.

Good measures of precisions were calculated for the survey months where larger numbers of great black-backed gulls were recorded (CV ≤ 0.16; Table 29). Outside these months, CV values of 0.2 to 0.6 for Caledonia OWF were more common, with larger values reported in surveys where fewer birds were observed. For Caledonia OWF plus buffer regions, CV values were generally lower than the corresponding CV values for Caledonia OWF, indicating higher precision within these reporting regions (Table 29). This was likely a product of an increased number of records, coupled with higher transect numbers and lengths within these reporting regions relative to Caledonia OWF (Table 1).

**Table 29** **Raw counts, unapportioned and apportioned abundance and density estimates (birds per km$^2$) of great black-backed gulls in Caledonia OWF, Caledonia OWF plus 2 km buffer and the Survey Area during the May 2021 to April 2023 survey period. Colour gradients follow the ascending order of great black-backed gull raw counts per season, with light yellow for the breeding season months (April to July) and light blue to royal blue (peak number) for the wintering months (September to March)**

| Survey | Raw count | Total unapportioned | | | | | Total apportioned | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Abundance | LCL | UCL | Precision (CV) | Density (km$^2$) | Abundance | LCL | UCL | Density (km$^2$) |
| **a) Caledonia OWF** | | | | | | | | | | |
| **Sep-21** | 12 | 70 | 12 | 197 | 0.29 | 0.16 | 81 | 14 | 215 | 0.19 |

| Survey | Raw count | Total unapportioned | | | | | Total apportioned | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Abundance | LCL | UCL | Precision (CV) | Density (km²) | Abundance | LCL | UCL | Density (km²) |
| Oct-21 | 3 | 18 | 3 | 53 | 0.58 | 0.04 | 32 | 7 | 87 | 0.07 |
| Nov-21 | 73 | 424 | 197 | 755 | 0.12 | 0.99 | 473 | 189 | 923 | 1.11 |
| Dec-21 | 8 | 46 | 17 | 75 | 0.35 | 0.11 | 46 | 10 | 98 | 0.11 |
| Jan-22 | 20 | 116 | 52 | 174 | 0.22 | 0.27 | 116 | 41 | 186 | 0.27 |
| Feb-22 | 20 | 108 | 43 | 184 | 0.22 | 0.25 | 108 | 22 | 216 | 0.25 |
| Aug-22 | 0 | - | - | - | - | - | 1 | 0 | 3 | 0.00 |
| Sep-22 | 3 | 17 | 6 | 35 | 1.00 | 0.04 | 18 | 3 | 46 | 0.04 |
| Oct-22 | 18 | 105 | 47 | 169 | 0.58 | 0.25 | 105 | 37 | 187 | 0.25 |
| Nov-22 | 5 | 29 | 6 | 65 | 0.24 | 0.07 | 34 | 8 | 78 | 0.08 |
| Dec-22 | 1 | 6 | 1 | 18 | 0.45 | 0.01 | 7 | 1 | 21 | 0.02 |
| Jan-23 | 18 | 105 | 52 | 175 | 1.00 | 0.25 | 105 | 35 | 186 | 0.25 |
| Feb-23 | 6 | 34 | 11 | 57 | 0.24 | 0.08 | 34 | 9 | 68 | 0.08 |
| b) Caledonia OWF plus 2 km buffer | | | | | | | | | | |
| Aug-21 | 3 | 17 | 3 | 51 | 0.58 | 0.03 | 17 | 3 | 51 | 0.03 |
| Sep-21 | 41 | 235 | 46 | 465 | 0.16 | 0.37 | 253 | 55 | 556 | 0.39 |
| Oct-21 | 23 | 133 | 23 | 311 | 0.21 | 0.21 | 159 | 28 | 369 | 0.25 |
| Nov-21 | 119 | 681 | 383 | 1,058 | 0.09 | 1.06 | 760 | 372 | 1,294 | 1.18 |
| Dec-21 | 11 | 63 | 29 | 97 | 0.30 | 0.1 | 63 | 16 | 120 | 0.1 |
| Jan-22 | 37 | 211 | 114 | 303 | 0.16 | 0.33 | 217 | 105 | 348 | 0.34 |
| Feb-22 | 34 | 182 | 96 | 284 | 0.17 | 0.28 | 185 | 72 | 319 | 0.29 |
| Mar-22 | 1 | 5 | 1 | 16 | 1.00 | 0.01 | 0 | 1 | 16 | 0 |
| Aug-22 | 0 | - | - | - | - | - | 6 | 1 | 17 | 0.01 |
| Sep-22 | 8 | 46 | 12 | 92 | 0.35 | 0.07 | 47 | 10 | 104 | 0.07 |
| Oct-22 | 27 | 157 | 99 | 227 | 0.19 | 0.24 | 162 | 71 | 265 | 0.25 |
| Nov-22 | 16 | 93 | 64 | 116 | 0.25 | 0.14 | 98 | 47 | 193 | 0.15 |
| Dec-22 | 8 | 47 | 18 | 88 | 0.35 | 0.07 | 51 | 14 | 99 | 0.08 |
| Jan-23 | 24 | 139 | 58 | 238 | 0.20 | 0.22 | 140 | 40 | 256 | 0.22 |
| Feb-23 | 10 | 57 | 29 | 86 | 0.32 | 0.09 | 58 | 17 | 103 | 0.09 |
| Mar-23 | 3 | 17 | 3 | 35 | 0.58 | 0.03 | 18 | 3 | 41 | 0.03 |
| Apr-23 | 0 | - | - | - | - | - | 4 | 1 | 10 | 0.01 |
| c) Survey Area | | | | | | | | | | |
| Aug-21 | 3 | 17 | 3 | 52 | 0.58 | 0.02 | 17 | 3 | 52 | 0.02 |
| Sep-21 | 76 | 445 | 170 | 773 | 0.11 | 0.5 | 468 | 122 | 942 | 0.53 |
| Oct-21 | 46 | 269 | 82 | 474 | 0.15 | 0.3 | 294 | 93 | 543 | 0.33 |
| Nov-21 | 163 | 949 | 553 | 1,444 | 0.08 | 1.07 | 1,046 | 519 | 1,745 | 1.18 |
| Dec-21 | 15 | 87 | 52 | 122 | 0.26 | 0.1 | 87 | 30 | 157 | 0.10 |
| Jan-22 | 48 | 278 | 174 | 382 | 0.14 | 0.31 | 284 | 170 | 416 | 0.32 |
| Feb-22 | 43 | 236 | 126 | 379 | 0.15 | 0.27 | 237 | 91 | 413 | 0.27 |
| Mar-22 | 2 | 11 | 2 | 27 | 0.71 | 0.01 | 11 | 2 | 27 | 0.01 |
| Aug-22 | 0 | - | - | - | - | - | 6 | 1 | 17 | 0.01 |
| Sep-22 | 12 | 70 | 12 | 140 | 0.29 | 0.08 | 70 | 14 | 158 | 0.08 |
| Oct-22 | 38 | 223 | 147 | 306 | 0.16 | 0.25 | 229 | 119 | 351 | 0.26 |
| Nov-22 | 19 | 112 | 88 | 136 | 0.23 | 0.13 | 119 | 48 | 210 | 0.13 |
| Dec-22 | 22 | 130 | 65 | 206 | 0.21 | 0.15 | 137 | 50 | 259 | 0.15 |
| Jan-23 | 33 | 194 | 88 | 312 | 0.17 | 0.22 | 194 | 77 | 336 | 0.22 |
| Feb-23 | 15 | 87 | 46 | 127 | 0.26 | 0.1 | 87 | 35 | 156 | 0.10 |
| Mar-23 | 5 | 29 | 6 | 59 | 0.45 | 0.03 | 29 | 7 | 60 | 0.03 |
| Apr-23 | 0 | - | - | - | - | - | 5 | 1 | 12 | 0.01 |

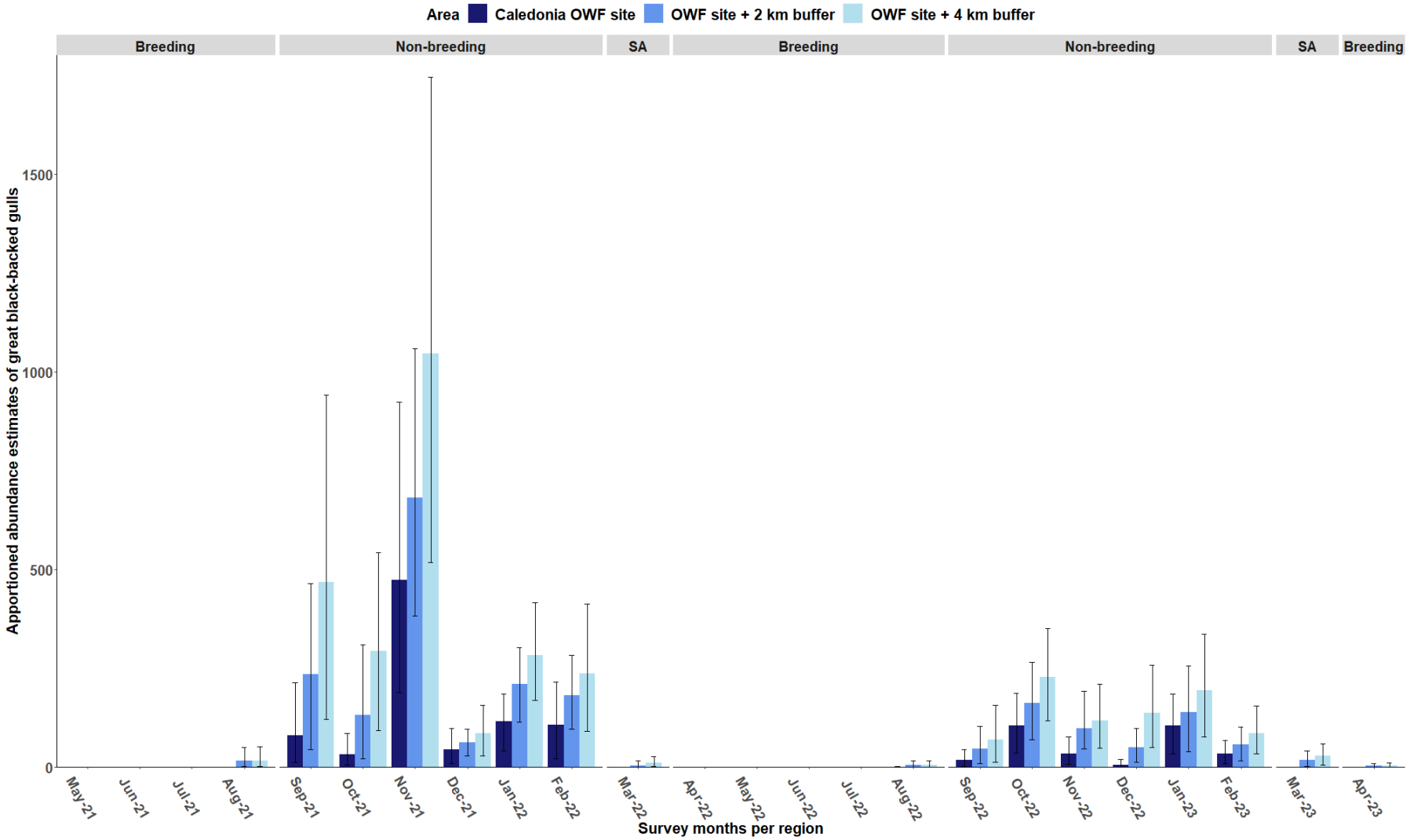



**Figure 6 Bar plot of monthly apportioned abundance estimates (with 95% confidence intervals) of total great black-backed gulls recorded in each reporting region of the Survey Area, during the May 2021 to April 2023 survey period. Great black-backed gull seasonal periods are also displayed. SA stands for breeding site attendance**

### *Caledonia North*

A total of 376 great black-backed gulls were recorded in Caledonia North Survey Area during both years of baseline surveys (Table 9). Great black-backed gulls were most abundant in all reporting regions during the non-breeding season. They were recorded from September 2021 to February 2022 and September 2022 to February 2023 in Caledonia North (Table 9, Table 30, Figure 7) while they were additionally present in low numbers in August 2021, March 2022 and March 2023 in Caledonia North plus 2 km and 4 km buffers (Table 30). In August 2022, great black-backed gulls have been recorded after apportioning despite not being directly recorded during the relevant survey (Table 30). This represents apportioning of black-backed gulls and/or large gull species into the great black-backed gull category, following the hierarchy outlined in Section 3.5.

Peak numbers were recorded in November 2021 (Table 30, Figure 7):

- 15 individuals were recorded in Caledonia North, resulting in an unapportioned mean abundance estimate of 88 [41; 134] and an apportioned mean abundance estimate of 93 [36; 155] individuals. These equated to mean density estimates of 0.40 (unapportioned) and 0.43 (apportioned) birds/km$^2$.
- 54 individuals were recorded in Caledonia North plus 2 km buffer, resulting in an unapportioned mean abundance estimate of 308 [154; 491] and an apportioned mean abundance estimate of 335 [140; 614] individuals. These equated to mean density estimates of 0.82 (unapportioned) and 0.89 (apportioned) birds/km$^2$.
- 84 individuals were recorded in Caledonia North Survey Area, resulting in an unapportioned mean abundance estimate of 490 [274; 747] and an apportioned mean abundance estimate of 533 [228; 976] individuals. These equated to mean density estimates of 0.88 (unapportioned) and 0.96 (apportioned) birds/km$^2$.

During the two non-breeding seasons covered by the baseline surveys, peak mean apportioned great black-backed gull abundances occurred within Caledonia North Survey Area in November 2021, October 2022 or January 2023 (depending on the reporting region), with other months considerably lower in mean apportioned abundances than the overall peak for the two years of surveys, in November 2021. In the 2021/22 non-breeding season, apportioned mean abundances were generally higher in the autumn than the winter period, with birds largely absent by the spring, presumably as birds move towards their breeding colonies. In the 2022/23 non-breeding season, mean apportioned abundances were comparable throughout most of the season. A key difference between the two non-breeding periods were the overall numbers of birds present, with the 2021/22 non-breeding season surveys recording larger numbers of birds than the 2022/23 non-breeding season surveys.

Reductions in mean apportioned abundance relative to the peak were between 12% to 99%, with most surveys reporting reductions closer to the upper limit. This indicates that the mean apportioned abundances were highly variable throughout the breeding season surveys when compared with the peak mean apportioned abundance for the baseline survey period, with many of the surveys recording apportioned mean abundances for this species that were considerably lower than the peak mean apportioned abundance.

Great black-backed gulls were recorded absent from Caledonia North Survey Area during the breeding season (April to July). They were only recorded in low numbers in March during the breeding site attendance period in Caledonia North 2 km and 4 km Buffer Zones (Table 30, Figure 7).

The 95% confidence intervals calculated for the mean abundances were sometimes relatively high even for surveys where CV values were low (e.g. September 2021 and November 2021 for Caledonia North Survey Area). This is perhaps a consequence of the numbers of birds in single samples (i.e. images) being highly variable. Where reporting regions were smaller (e.g. Caledonia North), it is possible that there was lower variability between samples, resulting in tighter 95% confidence intervals about the mean abundance estimate.

Good measures of precisions were calculated for the survey months where larger numbers of great black-backed gulls were recorded (CV ≤ 0.16; Table 30). Outside these months, CV values of around 0.2 to 0.7 for Caledonia North were more common, with larger values reported in surveys where fewer birds were observed (Table 30). For Caledonia North plus buffer regions, CV values were generally lower than the corresponding CV values for Caledonia North, indicating higher precision within these reporting regions (Table 30). This was likely a product of an increased number of records, coupled with higher transect numbers and lengths within these reporting regions relative to Caledonia North (Table 1).

**Table 30** **Raw counts, unapportioned and apportioned abundance and density estimates (birds per km$^2$) of great black-backed gulls in Caledonia North, Caledonia North plus 2 km buffer and Caledonia North Survey Area during the May 2021 to April 2023 survey period. Colour gradients follow the ascending order of great black-backed gull raw counts per season, with light yellow for the breeding season months (April to July) and light blue to royal blue (peak number) for the wintering months (September to March)**

| Survey | Raw count | Total unapportioned | | | | | Total apportioned | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Abundance | LCL | UCL | Precision (CV) | Density (km$^2$) | Abundance | LCL | UCL | Density (km$^2$) |
| **a)** | **Caledonia North** | | | | | | | | | |
| **Sep-21** | 12 | 70 | 12 | 185 | 0.29 | 0.32 | 81 | 14 | 209 | 0.37 |
| **Oct-21** | 3 | 18 | 3 | 53 | 0.58 | 0.08 | 32 | 7 | 83 | 0.15 |
| **Nov-21** | **15** | **88** | **41** | **134** | **0.26** | **0.40** | **93** | **36** | **155** | **0.43** |
| **Dec-21** | 4 | 23 | 4 | 46 | 0.50 | 0.11 | 24 | 4 | 70 | 0.11 |
| **Jan-22** | 9 | 52 | 17 | 93 | 0.33 | 0.24 | 52 | 18 | 104 | 0.24 |
| **Feb-22** | 12 | 65 | 12 | 129 | 0.29 | 0.30 | 65 | 13 | 129 | 0.30 |
| **Sep-22** | 2 | 11 | 2 | 23 | 0.71 | 0.05 | 11 | 2 | 23 | 0.05 |
| **Oct-22** | 8 | 46 | 23 | 69 | 0.35 | 0.21 | 47 | 14 | 81 | 0.22 |
| **Nov-22** | 4 | 24 | 4 | 47 | 0.50 | 0.11 | 24 | 4 | 59 | 0.11 |
| **Dec-22** | 1 | 6 | 1 | 17 | 1.00 | 0.03 | 6 | 1 | 17 | 0.03 |
| **Jan-23** | 9 | 52 | 23 | 81 | 0.33 | 0.24 | 52 | 18 | 92 | 0.24 |
| **Feb-23** | 2 | 12 | 2 | 29 | 0.71 | 0.05 | 12 | 2 | 23 | 0.05 |
| **b)** | **Caledonia North plus 2 km buffer** | | | | | | | | | |
| **Aug-21** | 3 | 17 | 3 | 51 | 0.58 | 0.05 | 17 | 3 | 51 | 0.05 |
| **Sep-21** | 41 | 233 | 46 | 444 | 0.16 | 0.62 | 250 | 67 | 563 | 0.67 |
| **Oct-21** | 23 | 131 | 23 | 309 | 0.21 | 0.35 | 158 | 28 | 354 | 0.42 |
| **Nov-21** | **54** | **308** | **154** | **491** | **0.14** | **0.82** | **335** | **140** | **614** | **0.89** |
| **Dec-21** | 7 | 40 | 11 | 74 | 0.38 | 0.11 | 40 | 7 | 97 | 0.11 |
| **Jan-22** | 24 | 136 | 74 | 204 | 0.20 | 0.36 | 143 | 59 | 244 | 0.38 |
| **Feb-22** | 19 | 102 | 27 | 199 | 0.23 | 0.27 | 104 | 22 | 217 | 0.28 |
| **Mar-22** | 1 | 5 | 1 | 16 | 1.00 | 0.01 | 5 | 1 | 16 | 0.01 |
| **Aug-22** | - | - | - | - | - | - | 6 | 1 | 17 | 0.02 |
| **Sep-22** | 7 | 41 | 7 | 87 | 0.38 | 0.11 | 41 | 9 | 93 | 0.11 |
| **Oct-22** | 14 | 82 | 53 | 112 | 0.27 | 0.22 | 88 | 42 | 150 | 0.24 |
| **Nov-22** | 10 | 58 | 29 | 81 | 0.32 | 0.15 | 58 | 20 | 115 | 0.15 |
| **Dec-22** | 5 | 29 | 5 | 65 | 0.45 | 0.08 | 32 | 5 | 70 | 0.08 |
| **Jan-23** | 17 | 100 | 35 | 176 | 0.24 | 0.27 | 100 | 30 | 205 | 0.27 |
| **Feb-23** | 5 | 29 | 11 | 46 | 0.45 | 0.08 | 28 | 8 | 63 | 0.07 |
| **Mar-23** | 2 | 12 | 2 | 29 | 0.71 | 0.03 | 12 | 2 | 34 | 0.03 |
| **c)** | **Caledonia North Survey Area** | | | | | | | | | |
| **Aug-21** | 3 | 17 | 3 | 52 | 0.58 | 0.03 | 17 | 3 | 52 | 0.03 |
| **Sep-21** | 76 | 444 | 193 | 730 | 0.11 | 0.80 | 467 | 122 | 946 | 0.84 |
| **Oct-21** | 46 | 269 | 99 | 479 | 0.15 | 0.48 | 294 | 93 | 553 | 0.53 |
| **Nov-21** | **84** | **490** | **274** | **747** | **0.11** | **0.88** | **533** | **228** | **976** | **0.96** |
| **Dec-21** | 9 | 52 | 23 | 82 | 0.33 | 0.09 | 52 | 10 | 116 | 0.09 |

| Survey | Raw count | Total unapportioned | | | | | Total apportioned | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Abundance | LCL | UCL | Precision (CV) | Density ($km^2$) | Abundance | LCL | UCL | Density ($km^2$) |
| **Jan-22** | 37 | 214 | 139 | 289 | 0.16 | 0.38 | 220 | 135 | 323 | 0.39 |
| **Feb-22** | 23 | 127 | 39 | 248 | 0.21 | 0.23 | 130 | 31 | 261 | 0.23 |
| **Mar-22** | 2 | 11 | 2 | 27 | 0.71 | 0.02 | 11 | 2 | 27 | 0.02 |
| **Aug-22** | 0 | - | - | - | - | - | 6 | 1 | 17 | 0.01 |
| **Sep-22** | 10 | 58 | 10 | 134 | 0.32 | 0.10 | 58 | 12 | 134 | 0.10 |
| **Oct-22** | 22 | 129 | 82 | 182 | 0.21 | 0.23 | 136 | 69 | 215 | 0.24 |
| **Nov-22** | 12 | 71 | 41 | 100 | 0.29 | 0.13 | 71 | 27 | 137 | 0.13 |
| **Dec-22** | 16 | 94 | 35 | 165 | 0.25 | 0.17 | 98 | 30 | 203 | 0.18 |
| **Jan-23** | 22 | 130 | 65 | 212 | 0.21 | 0.23 | 130 | 42 | 242 | 0.23 |
| **Feb-23** | 11 | 64 | 29 | 98 | 0.30 | 0.11 | 64 | 25 | 109 | 0.11 |
| **Mar-23** | 3 | 18 | 3 | 47 | 0.58 | 0.03 | 18 | 3 | 48 | 0.03 |

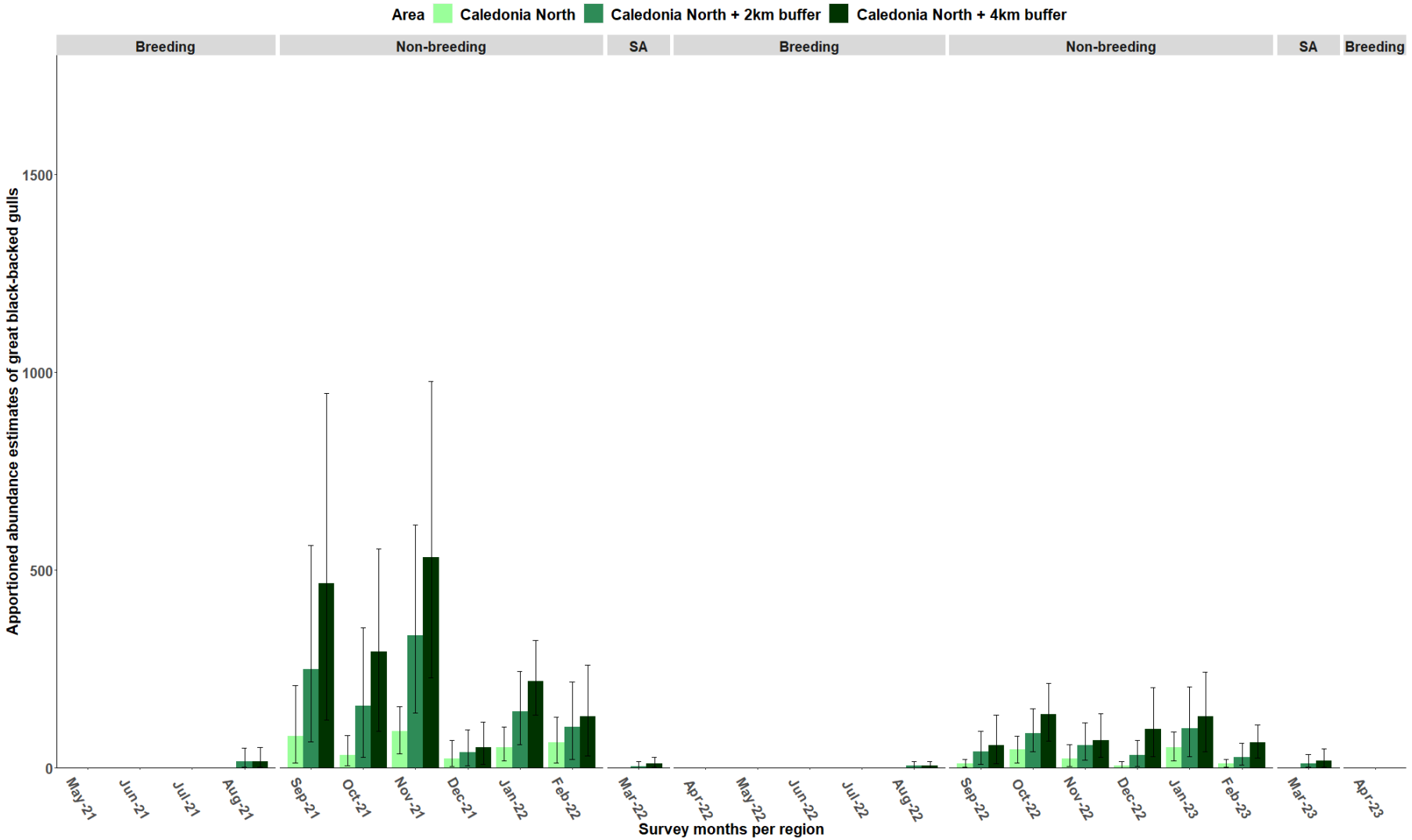



**Figure 7 Bar plot of monthly apportioned abundance estimates (with 95% confidence intervals) of the total great-black back gulls recorded in each reporting region of Caledonia North Survey Area, during the May 2021 to April 2023 survey period. Great black-backed gull seasonal periods are also displayed. SA stands for breeding site attendance**

### *Caledonia South*

A total of 258 great black-backed gulls were recorded in Caledonia South Survey Area during both years of baseline surveys (Table 10). Great black-backed gulls were only recorded from November 2021 to February 2022, September to November 2022 and January to February 2023 in Caledonia South (Table 31, Figure 8). They were additionally recorded in low numbers in March 2022 and March 2023 in Caledonia North plus 2 km buffer and additionally in April 2023 in Caledonia South Survey Area (Table 31). In April 2023, great black-backed gulls have been recorded, in Caledonia South plus 2 km buffer, after apportioning despite not being directly recorded during the relevant survey (Table 31). This represents apportioning of black-backed gulls and/or large gull species into the great black-backed gull category, following the hierarchy outlined in Section 3.5

Great black-backed gulls were the most abundant during the non-breeding season (September to February), with peak numbers in November 2021 (Table 31, Figure 8):

- 58 individuals were recorded in Caledonia South, resulting in an unapportioned mean abundance estimate of 334 [127; 651] and an apportioned mean abundance estimate of 377 [129; 776] individuals. These equated to mean density estimates of 1.59 (unapportioned) and 1.79 (apportioned) birds/km$^2$.
- 74 individuals were recorded in Caledonia South plus 2 km buffer, resulting in an unapportioned mean abundance estimate of 424 [212; 739] and an apportioned mean abundance estimate of 481 [240; 892] individuals. These equated to mean density estimates of 1.18 (unapportioned) and 1.34 (apportioned) birds/km$^2$.
- 96 individuals were recorded in Caledonia South Survey Area, resulting in an unapportioned mean abundance estimate of 552 [259; 937], and an apportioned mean abundance estimate of 632 [278; 1,132] individuals. These equated to mean density estimates of 1.03 (unapportioned) and 1.18 (apportioned) birds/km$^2$.

During the two non-breeding seasons covered by the baseline surveys, peak mean apportioned abundances of great black-backed gull occurred in Caledonia South Survey Area in November 2021 and October 2022, with other months considerably lower in mean apportioned abundances than the overall peak for the two years of surveys, in November 2021. Other than this large peak mean abundance, mean apportioned abundances were comparable throughout most of the non-breeding season surveys covered by the baseline survey period.

Reductions in mean apportioned abundance relative to the peak were between 74% to 99%, indicating relatively low variability in mean apportioned abundances in non-breeding season surveys relative to the mean peak abundance.

Great black-backed gulls were mostly absent from Caledonia South Survey Area during the breeding season (April to July), with the exception of April 2023 where they were recorded in low numbers in Caledonia South 4 km Buffer Zone (Table 31). This led to small numbers of apportioned birds being allocated to this species within other regions within Caledonia South Survey Area.

The 95% confidence intervals calculated for the mean abundances were sometimes relatively high even for surveys where CV values were low (e.g. November 2021 for Caledonia North Survey Area). This is perhaps a consequence of the numbers of birds in single samples (i.e. images) being highly variable. Where reporting regions were smaller (e.g. Caledonia South), it is possible that there was lower variability between samples, resulting in tighter 95% confidence intervals about the mean abundance estimate.

Good measures of precision were calculated for the survey months where larger numbers of great black-backed gulls were recorded (CV ≤ 0.16; Table 31). Outside these months, CV values of around 0.2 to 0.5 for Caledonia South were more common, with larger values reported in surveys where fewer birds were observed (Table 31). For Caledonia South plus buffers, CV values were generally lower than

the corresponding CV values for Caledonia South, indicating higher precision within these reporting regions (Table 31). This was likely a product of an increased number of records, coupled with higher transect numbers and lengths within these reporting regions relative to Caledonia South (Table 1).

**Table 31** **Raw counts, unapportioned and apportioned abundance and density estimates (birds per km$^2$) of great black-backed gulls in Caledonia South, Caledonia South plus 2 km buffer and Caledonia South Survey Area during the May 2021 to April 2023 survey period. Colour gradients follow the ascending order of great black-backed gull raw counts per season, with light yellow for the breeding season months (April to July) and light blue to royal blue (peak number) for the wintering months (September to March)**

| Survey | Raw count | Total unapportioned | | | | | Total apportioned | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Abundance | LCL | UCL | Precision (CV) | Density (km$^2$) | Abundance | LCL | UCL | Density (km$^2$) |
| **a)** | **Caledonia South** | | | | | | | | | |
| **Nov-21** | **58** | **334** | **127** | **651** | **0.13** | **1.59** | **377** | **129** | **776** | **1.79** |
| **Dec-21** | 4 | 23 | 6 | 46 | 0.50 | 0.11 | 24 | 4 | 52 | 0.11 |
| **Jan-22** | 11 | 64 | 35 | 92 | 0.30 | 0.30 | 63 | 20 | 110 | 0.30 |
| **Feb-22** | 8 | 43 | 11 | 76 | 0.35 | 0.20 | 43 | 8 | 98 | 0.20 |
| **Sep-22** | 1 | 6 | 1 | 17 | 1.00 | 0.03 | 5 | 1 | 16 | 0.02 |
| **Oct-22** | 10 | 59 | 24 | 100 | 0.32 | 0.28 | 6 | 1 | 17 | 0.03 |
| **Nov-22** | 1 | 6 | 1 | 18 | 1.00 | 0.03 | 59 | 24 | 100 | 0.28 |
| **Jan-23** | 9 | 53 | 18 | 94 | 0.33 | 0.25 | 8 | 1 | 27 | 0.04 |
| **Feb-23** | 4 | 23 | 6 | 40 | 0.50 | 0.11 | 52 | 12 | 100 | 0.25 |
| **b)** | **Caledonia South plus 2 km buffer** | | | | | | | | | |
| **Oct-21** | - | - | - | - | - | - | 5 | 5 | 15 | 0.02 |
| **Nov-21** | **74** | **424** | **212** | **739** | **0.12** | **1.18** | **481** | **240** | **892** | **1.34** |
| **Dec-21** | 5 | 29 | 6 | 58 | 0.45 | 0.08 | 29 | 5 | 64 | 0.08 |
| **Jan-22** | 17 | 98 | 46 | 149 | 0.24 | 0.27 | 97 | 34 | 160 | 0.27 |
| **Feb-22** | 19 | 101 | 64 | 139 | 0.23 | 0.28 | 102 | 29 | 186 | 0.28 |
| **Mar-22** | - | - | - | - | - | - | 5 | 5 | 16 | 0.01 |
| **Sep-22** | 2 | 11 | 2 | 29 | 0.71 | 0.03 | 11 | 2 | 29 | 0.03 |
| **Oct-22** | 15 | 86 | 40 | 132 | 0.26 | 0.24 | 87 | 37 | 162 | 0.24 |
| **Nov-22** | 10 | 58 | 29 | 87 | 0.32 | 0.16 | 64 | 30 | 126 | 0.18 |
| **Dec-22** | 3 | 17 | 6 | 35 | 0.58 | 0.05 | 19 | 5 | 39 | 0.05 |
| **Jan-23** | 10 | 57 | 23 | 98 | 0.32 | 0.16 | 58 | 16 | 103 | 0.16 |
| **Feb-23** | 7 | 40 | 11 | 68 | 0.38 | 0.11 | 40 | 9 | 74 | 0.11 |
| **Mar-23** | 2 | 12 | 2 | 29 | 0.71 | 0.03 | 12 | 2 | 29 | 0.03 |
| **Apr-23** | - | - | - | - | - | - | 6 | 6 | 17 | 0.02 |
| **c)** | **Caledonia South Survey Area** | | | | | | | | | |
| **Sep-21** | 14 | 81 | 14 | 244 | 0.27 | 0.15 | 81 | 14 | 243 | 0.15 |
| **Oct-21** | 1 | 6 | 1 | 17 | 1.00 | 0.01 | 12 | 2 | 34 | 0.02 |
| **Nov-21** | **96** | **552** | **259** | **937** | **0.10** | **1.03** | **632** | **278** | **1,132** | **1.18** |
| **Dec-21** | 7 | 40 | 12 | 69 | 0.38 | 0.07 | 40 | 7 | 87 | 0.07 |
| **Jan-22** | 26 | 150 | 86 | 219 | 0.20 | 0.28 | 150 | 69 | 230 | 0.28 |
| **Feb-22** | 30 | 163 | 87 | 255 | 0.18 | 0.31 | 163 | 66 | 276 | 0.31 |
| **Mar-22** | 1 | 5 | 1 | 16 | 1.00 | 0.01 | 10 | 2 | 32 | 0.02 |
| **Sep-22** | 4 | 23 | 6 | 41 | 0.50 | 0.04 | 24 | 4 | 53 | 0.04 |
| **Oct-22** | 24 | 141 | 76 | 206 | 0.20 | 0.26 | 141 | 73 | 235 | 0.26 |
| **Nov-22** | 14 | 82 | 47 | 117 | 0.27 | 0.15 | 86 | 28 | 156 | 0.16 |
| **Dec-22** | 11 | 65 | 18 | 118 | 0.30 | 0.12 | 66 | 18 | 142 | 0.12 |
| **Jan-23** | 18 | 105 | 41 | 181 | 0.24 | 0.20 | 105 | 24 | 211 | 0.20 |
| **Feb-23** | 9 | 52 | 23 | 81 | 0.33 | 0.10 | 52 | 18 | 86 | 0.10 |
| **Mar-23** | 3 | 17 | 3 | 35 | 0.58 | 0.03 | 17 | 3 | 35 | 0.03 |
| **Apr-23** | 14 | 81 | 14 | 244 | 0.27 | 0.15 | 6 | 1 | 17 | 0.01 |

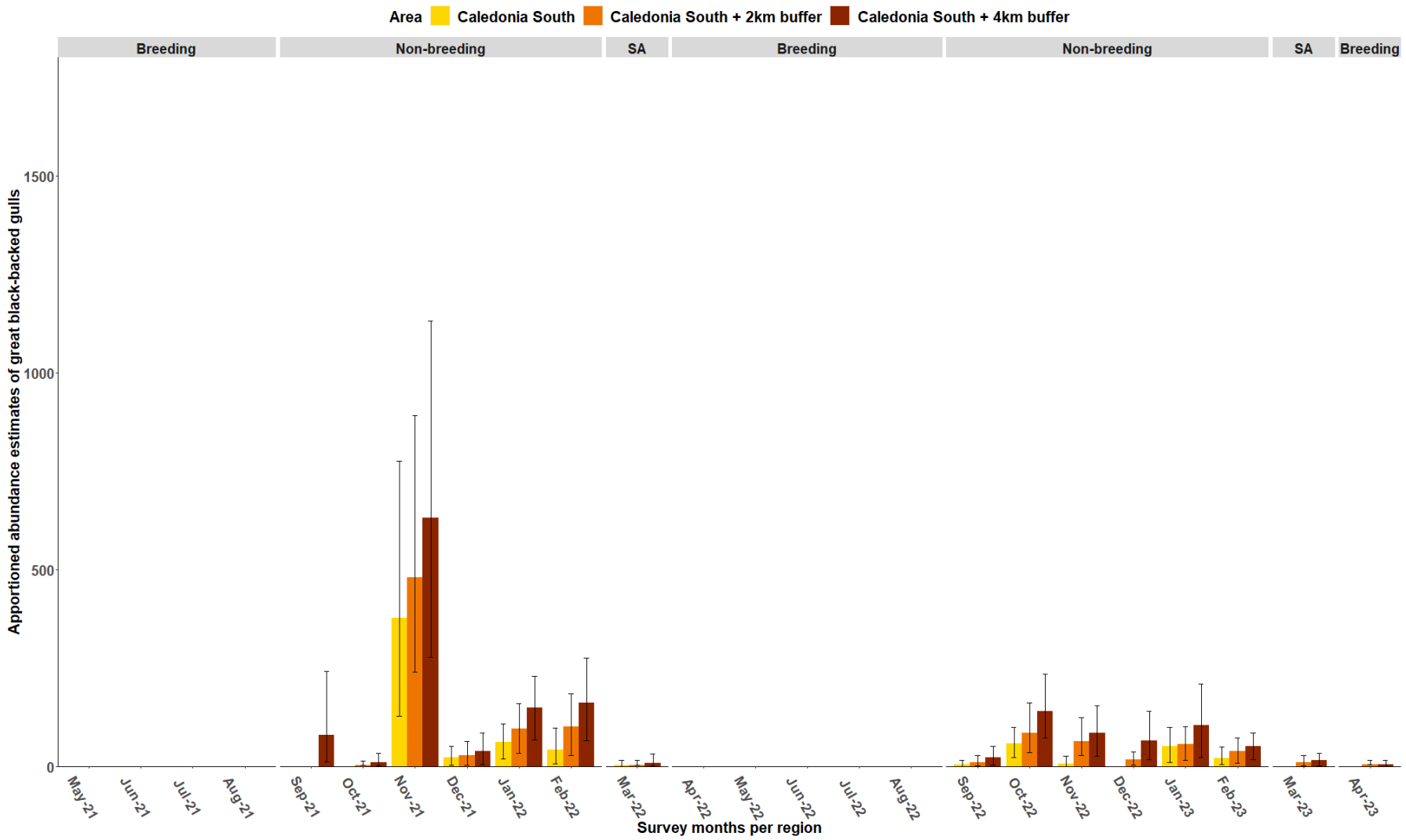



**Figure 8 Bar plot of monthly apportioned abundance estimates (with 95% confidence intervals) of the total great-black back gulls recorded in each reporting region of Caledonia South Survey Area, during the May 2021 to April 2023 survey period. Great-black back gull seasonal periods are also displayed. SA stands for breeding site attendance**

### *ii. Distribution and behaviour*

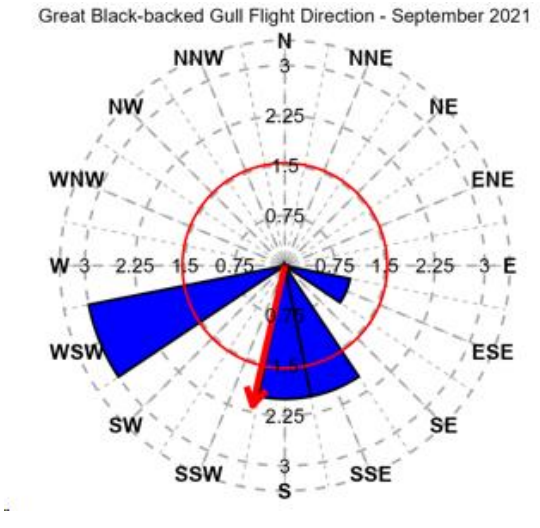
Maps of distribution are shown in Appendix 4: Figures A4.33-47. Great black-backed gulls were absent from the Survey Area during May to July 2021 surveys, which coincides with the migration-free breeding season for this species. This indicates that the Survey Area was of limited or no importance to nearby SPA breeding colonies of this species (e.g. East Caithness Cliffs SPA, Copinsay SPA and Hoy SPA).

In August, September and October 2021, and September 2022, great black-backed gulls were concentrated in the west of the Survey Area, predominantly within the Buffer Zone, in the vicinity of operational Moray East wind turbines (Figures A4.33-35, A4.41). In December 2021, they were distributed in the south and west of the Survey Area, with most individuals within the Buffer Zone (Figure A4.37). During the November 2021, January, February and October 2022 surveys, they were widely distributed throughout the Survey Area (Figures A4.36, 38-39, 42). The two individuals recorded in March 2022 were both within the Buffer Zone; one in Caledonia North Buffer Zone near the Caledonia North boundary and one in the northwest of Caledonia South Buffer Zone (Figure A4.40). In November 2022, great black-backed gulls were scattered throughout the Survey Area, with highest numbers along the subdivision line of Caledonia North and Caledonia South, and southern parts of Caledonia South Buffer Zone (Figure A4.43). In December 2022, individuals were predominantly recorded within the Survey Area Buffer Zone, with most of them recorded in the west and east of Caledonia North Buffer Zone (Figure A4.44). In January 2023, they were mainly recorded towards the centre of the Survey Area (Figure A4.45), while individuals occurred more scattered across the Survey Area in February and in the west of the Survey Area Buffer Zone in March 2023 (Figures A4.46-47).

Significant predominant direction of flight was recorded in:

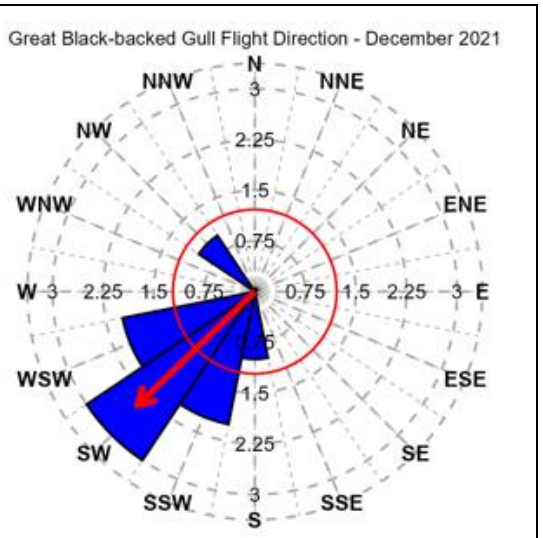
- **September**
  - 2021 south-southwest (Figure 9a)
- **December**
  - 2021 southwest (Figure 9b)
  - 2022 west (Figure 9f)
- **January**
  - 2022 west-southwest (Figure 9c)
  - 2023 south-southwest (Figure 9g)
- **February**
  - 2022 south (Figure 9d)
- **November**
  - 2022 south-southeast (Figure 9e)

As very few birds were recorded in flight in other surveys, they were too infrequent to determine any preference in flight direction (Appendix 5, Figure A5.6).



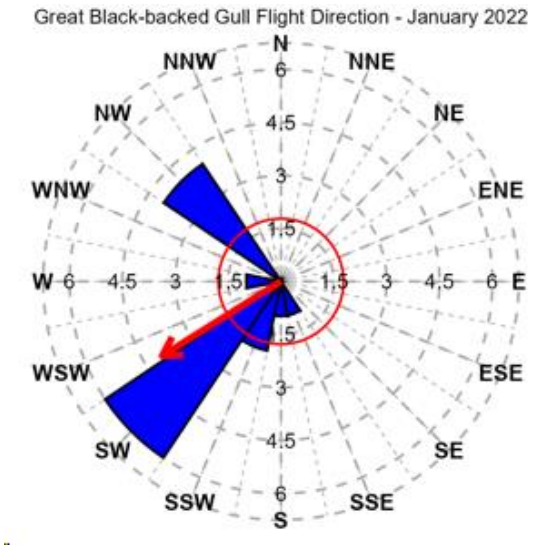

| | |
|---|---|
| Number of Observations | 8 |
| Mean Vector (μ) | 193.006 |
| Length of Mean Vector (r) | 0.718 |
| Rayleigh Test (Z) | 4.119 |
| Rayleigh Test (p) | 0.011 |

**a September 2021**



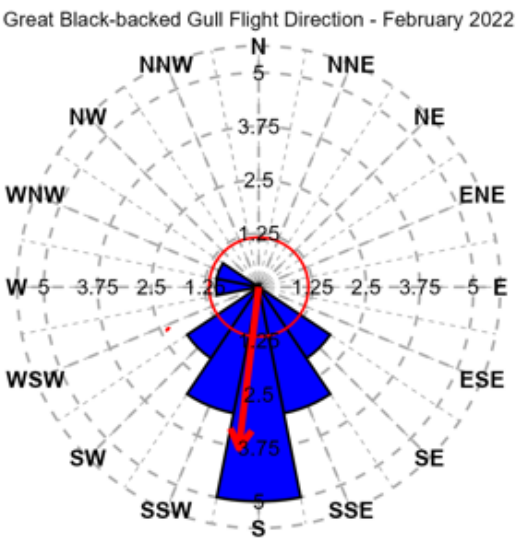

| | |
|---|---|
| Number of Observations | 9 |
| Mean Vector (μ) | 226.451 |
| Length of Mean Vector (r) | 0.807 |
| Rayleigh Test (Z) | 5.861 |
| Rayleigh Test (p) | 0.001 |

**b December 2021**



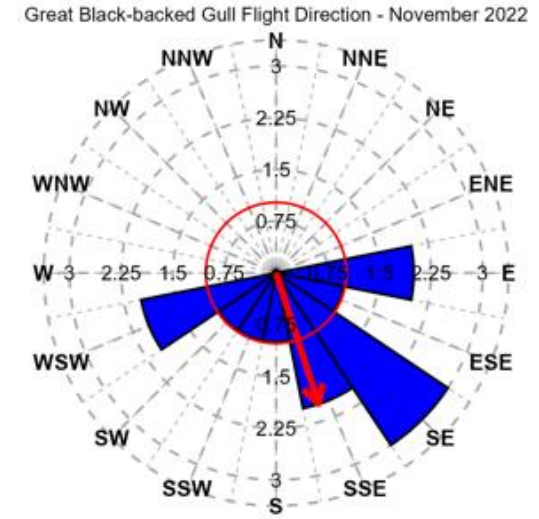

| | |
|---|---|
| Number of Observations | 15 |
| Mean Vector (μ) | 238.347 |
| Length of Mean Vector (r) | 0.662 |
| Rayleigh Test (Z) | 6.569 |
| Rayleigh Test (p) | <0.001 |

**c January 2022**



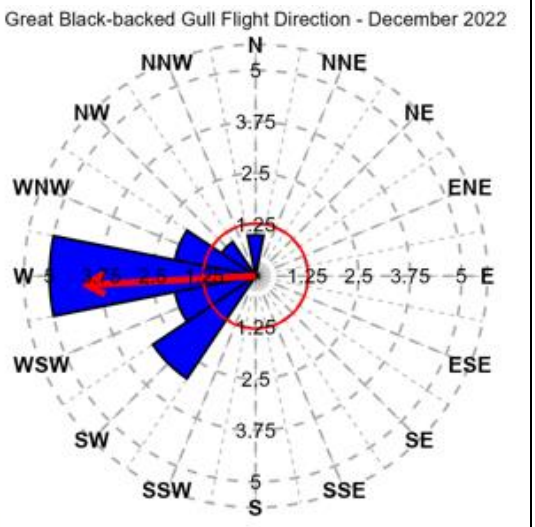

| | |
|---|---|
| Number of Observations | 17 |
| Mean Vector (μ) | 188.949 |
| Length of Mean Vector (r) | 0.756 |
| Rayleigh Test (Z) | 9.726 |
| Rayleigh Test (p) | <0.001 |

**d February 2022**



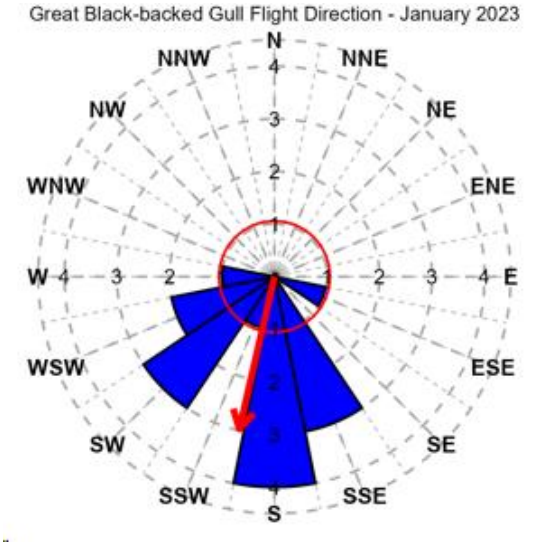

| | |
|---|---|
| Number of Observations | 13 |
| Mean Vector (μ) | 162.164 |
| Length of Mean Vector (r) | 0.664 |
| Rayleigh Test (Z) | 5.729 |
| Rayleigh Test (p) | 0.002 |

**e November 2022**




| | |
|---|---|
| Number of Observations | 14 |
| Mean Vector (μ) | 267.340 |
| Length of Mean Vector (r) | 0.821 |
| Rayleigh Test (Z) | 9.437 |
| Rayleigh Test (p) | <0.001 |

**f December 2022**




| | |
|---|---|
| Number of Observations | 15 |
| Mean Vector (μ) | 193.113 |
| Length of Mean Vector (r) | 0.742 |
| Rayleigh Test (Z) | 8.260 |
| Rayleigh Test (p) | <0.001 |

**g January 2023**

**Figure 9 Summary of flight direction of great black-backed gulls, within surveys where a significant flight direction was recorded during the May 2021 to April 2023 survey period**

## 4.7 Herring gull

### *i. Abundance and estimates*

#### *Caledonia OWF*

A total of 99 herring gulls were recorded in the Survey Area during both years of baseline surveys (Table 8). Herring gulls were recorded in low numbers in all baseline surveys, except August 2021, April, May, August and September 2022, January and April 2023 (Table 8, Table 32, Figure 10). Herring gulls were the most abundant during the non-breeding season (September to March), with peak numbers recorded in November 2021 (Table 32, Figure 10):

- Seven individuals were recorded in Caledonia OWF, resulting in an unapportioned mean abundance estimate of 41 [7; 93], and an apportioned mean abundance estimate of 45 [7; 99] individuals. These equated to mean density estimates of 0.10 (unapportioned) and 0.11 (apportioned) birds/km$^2$.
- 14 individuals were recorded in Caledonia OWF plus 2 km buffer, resulting in an unapportioned mean abundance estimate of 80 [29; 137] and an apportioned mean abundance estimate of 87 [26; 176] individuals. These equated to mean density estimates of 0.12 (unapportioned) and 0.14 (apportioned) birds/km$^2$.
- 14 individuals were recorded in the Survey Area, resulting in an unapportioned mean abundance estimate of 81 [29; 146] and an apportioned mean abundance estimate of 90 [27; 176] individuals. These equated to mean density estimates of 0.09 (unapportioned) and 0.10 (apportioned) birds/km$^2$.

During the non-breeding seasons covered by the baseline surveys, herring gull numbers peaked in November 2021 and December 2022, with numbers steadily growing each month prior to the peak. Both January to March periods covered by the baseline surveys recorded low numbers of birds. Whilst birds were present more consistently than the breeding season, it is still considered that Caledonia Survey Area is situated is of limited importance to this species during the non-breeding season.

Numbers of herring gulls recorded in the breeding season (April to August) were generally slightly lower than during the non-breeding season. The peak abundance was recorded in July 2022 (Table 32):

- Six individuals were recorded in Caledonia OWF, resulting in an unapportioned mean abundance estimate of 35 [6; 82], and an apportioned mean abundance estimate of 63 [11; 152] individuals. These equated to mean density estimates of 0.08 (unapportioned) and 0.15 (apportioned) birds/km$^2$.
- Seven individuals were recorded in Caledonia OWF plus 2 km buffer, resulting in an unapportioned mean abundance estimate of 40 [7; 92] and an apportioned mean abundance estimate of 77 [20; 175] individuals. These equated to mean density estimates of 0.06 (unapportioned) and 0.12 (apportioned) birds/km$^2$.
- 29 individuals were recorded in the Survey Area, resulting in an unapportioned mean abundance estimate of 169 [53; 310] and an apportioned mean abundance estimate of 219 [41; 494] individuals. These equated to mean density estimates of 0.19 (unapportioned) and 0.25 (apportioned) birds/km$^2$.

In March 2022 and 2023, during the breeding site attendance period, only a single individual was recorded in the Survey Area. In March 2022, an unapportioned mean abundance of 5 [1; 16] and an apportioned mean abundance of 10 [2; 32] individuals were estimated across all regions (Table 32). This equated to mean density estimates of 0.01 (unapportioned) and 0.02 (apportioned) birds/km$^2$ (Table 32).

In both breeding seasons covered by the baseline surveys, apportioned mean herring gull abundances across the Survey Area were very low in April to June (being almost completely absent between April to June 2022), with larger (though still modest) numbers of birds present in July. Birds were absent in August 2021 and 2022. This indicates that the area in which Caledonia Survey Area is situated is of limited importance to this species during the breeding season.

Measures of precisions were high (indicating lower levels of precision), which is likely related to the low numbers of individuals recorded in each reporting region during each survey (CV > 0.16; Table 32).

**Table 32 Raw counts, unapportioned and apportioned abundance and density estimates (birds per km$^2$) of herring gulls in Caledonia OWF, Caledonia OWF plus 2 km buffer and the Survey Area during the May 2021 to April 2023 survey period. Colour gradients follow the ascending order of herring gull raw counts per season, with light yellow to orange (peak number) for the breeding season months (April to August) and light blue to royal blue (peak number) for the wintering months (September to March)**

| Survey | Raw count | Total unapportioned | | | | | Total apportioned | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Abundance | LCL | UCL | Precision (CV) | Density (km$^2$) | Abundance | LCL | UCL | Density (km$^2$) |
| **a) Caledonia OWF** | | | | | | | | | | |
| **May-21** | 1 | 6 | 1 | 17 | 1.00 | 0.01 | 6 | 1 | 17 | 0.01 |
| **Jun-21** | 1 | 6 | 1 | 18 | 1.00 | 0.01 | 6 | 1 | 18 | 0.01 |
| **Jul-21** | 0 | - | - | - | - | - | 7 | 1 | 16 | 0.02 |
| **Sep-21** | 1 | 6 | 1 | 17 | 1.00 | 0.01 | 6 | 1 | 17 | 0.01 |
| **Oct-21** | 3 | 18 | 3 | 41 | 0.58 | 0.04 | 27 | 5 | 66 | 0.06 |
| **Nov-21** | **7** | **41** | **7** | **93** | **0.38** | **0.1** | **45** | **7** | **99** | **0.11** |
| **Dec-21** | 2 | 12 | 2 | 29 | 0.71 | 0.03 | 12 | 2 | 29 | 0.03 |
| **Jan-22** | 1 | 6 | 1 | 17 | 1.00 | 0.01 | 6 | 1 | 17 | 0.01 |
| **Feb-22** | 2 | 11 | 2 | 27 | 0.71 | 0.03 | 10 | 2 | 32 | 0.02 |
| **Mar-22** | 1 | 5 | 1 | 16 | 1.00 | 0.01 | 10 | 2 | 32 | 0.02 |
| **Jul-22** | **6** | **35** | **6** | **82** | **0.41** | **0.08** | **63** | **11** | **152** | **0.15** |
| **Oct-22** | 2 | 12 | 2 | 29 | 0.71 | 0.03 | 12 | 2 | 29 | 0.03 |
| **Nov-22** | 3 | 18 | 3 | 35 | 0.58 | 0.04 | 20 | 3 | 48 | 0.05 |
| **Dec-22** | 5 | 29 | 5 | 76 | 0.45 | 0.07 | 32 | 5 | 82 | 0.08 |
| **Feb-23** | 1 | 6 | 1 | 17 | 1.00 | 0.01 | 6 | 1 | 17 | 0.01 |
| **Mar-23** | 1 | 6 | 1 | 18 | 1.00 | 0.01 | 6 | 1 | 18 | 0.01 |
| **Apr-23** | 0 | - | - | - | - | - | 6 | 1 | 17 | 0.01 |
| **b) Caledonia OWF plus 2 km buffer** | | | | | | | | | | |
| **May-21** | 1 | 6 | 1 | 17 | 1.00 | 0.01 | 6 | 1 | 17 | 0.01 |
| **Jun-21** | 1 | 6 | 1 | 17 | 1.00 | 0.01 | 6 | 1 | 17 | 0.01 |
| **Jul-21** | 0 | - | - | - | - | - | 12 | 2 | 16 | 0.02 |
| **Sep-21** | 1 | 6 | 1 | 17 | 1.00 | 0.01 | 6 | 1 | 17 | 0.01 |
| **Oct-21** | 3 | 17 | 3 | 46 | 0.58 | 0.03 | 21 | 4 | 52 | 0.03 |
| **Nov-21** | **14** | **80** | **29** | **137** | **0.27** | **0.12** | **87** | **26** | **176** | **0.14** |
| **Dec-21** | 3 | 17 | 3 | 40 | 0.58 | 0.03 | 17 | 3 | 40 | 0.03 |
| **Jan-22** | 1 | 6 | 1 | 17 | 1.00 | 0.01 | 6 | 1 | 17 | 0.01 |
| **Feb-22** | 2 | 11 | 2 | 27 | 0.71 | 0.02 | 10 | 2 | 33 | 0.02 |
| **Mar-22** | 1 | 5 | 1 | 16 | 1.00 | 0.01 | 10 | 2 | 32 | 0.02 |
| **Jul-22** | **7** | **40** | **7** | **92** | **0.38** | **0.06** | **77** | **20** | **175** | **0.12** |
| **Oct-22** | 2 | 12 | 2 | 29 | 0.71 | 0.02 | 13 | 2 | 31 | 0.02 |
| **Nov-22** | 3 | 17 | 3 | 35 | 0.58 | 0.03 | 19 | 3 | 52 | 0.03 |
| **Dec-22** | 6 | 35 | 6 | 93 | 0.41 | 0.05 | 39 | 7 | 113 | 0.06 |
| **Feb-23** | 2 | 11 | 2 | 29 | 0.71 | 0.02 | 11 | 2 | 29 | 0.02 |
| **Mar-23** | 1 | 6 | 1 | 17 | 1.00 | 0.01 | 6 | 1 | 17 | 0.01 |
| **Apr-23** | 0 | - | - | - | - | - | 2 | 0 | 7 | 0.00 |

| Survey | Raw count | Total unapportioned | | | | | Total apportioned | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Abundance | LCL | UCL | Precision (CV) | Density ($km^2$) | Abundance | LCL | UCL | Density ($km^2$) |
| c) Survey Area | | | | | | | | | | |
| **May-21** | 1 | 6 | 1 | 18 | 0.71 | 0.01 | 6 | 1 | 18 | 0.01 |
| **Jun-21** | 1 | 6 | 1 | 18 | 1.00 | 0.01 | 6 | 1 | 18 | 0.01 |
| **Jul-21** | 16 | 97 | 16 | 290 | 0.25 | 0.11 | 106 | 18 | 309 | 0.12 |
| **Sep-21** | 1 | 6 | 1 | 18 | 1.00 | 0.01 | 6 | 1 | 18 | 0.01 |
| **Oct-21** | 7 | 41 | 12 | 76 | 0.38 | 0.05 | 45 | 14 | 90 | 0.05 |
| **Nov-21** | **14** | **81** | **29** | **146** | **0.27** | **0.09** | **90** | **27** | **176** | **0.1** |
| **Dec-21** | 3 | 17 | 3 | 47 | 0.58 | 0.02 | 17 | 3 | 47 | 0.02 |
| **Jan-22** | 1 | 6 | 1 | 17 | 1.00 | 0.01 | 6 | 1 | 17 | 0.01 |
| **Feb-22** | 7 | 38 | 7 | 93 | 0.38 | 0.04 | 39 | 7 | 112 | 0.04 |
| **Mar-22** | 1 | 5 | 1 | 16 | 1.00 | 0.01 | 10 | 2 | 32 | 0.01 |
| **Jun-22** | 1 | 6 | 1 | 17 | 1.00 | 0.01 | 6 | 1 | 17 | 0.01 |
| **Jul-22** | **29** | **169** | **53** | **310** | **0.19** | **0.19** | **219** | **41** | **494** | **0.25** |
| **Oct-22** | 3 | 18 | 3 | 35 | 0.58 | 0.02 | 18 | 3 | 49 | 0.02 |
| **Nov-22** | 3 | 18 | 3 | 35 | 0.58 | 0.02 | 19 | 3 | 51 | 0.02 |
| **Dec-22** | 8 | 47 | 8 | 106 | 0.35 | 0.05 | 50 | 8 | 115 | 0.06 |
| **Feb-23** | 2 | 12 | 2 | 29 | 0.71 | 0.01 | 12 | 2 | 29 | 0.01 |
| **Mar-23** | 1 | 6 | 1 | 18 | 1.00 | 0.01 | 6 | 1 | 18 | 0.01 |
| **Apr-23** | 0 | - | - | - | - | - | 1 | 0 | 5 | 0.00 |

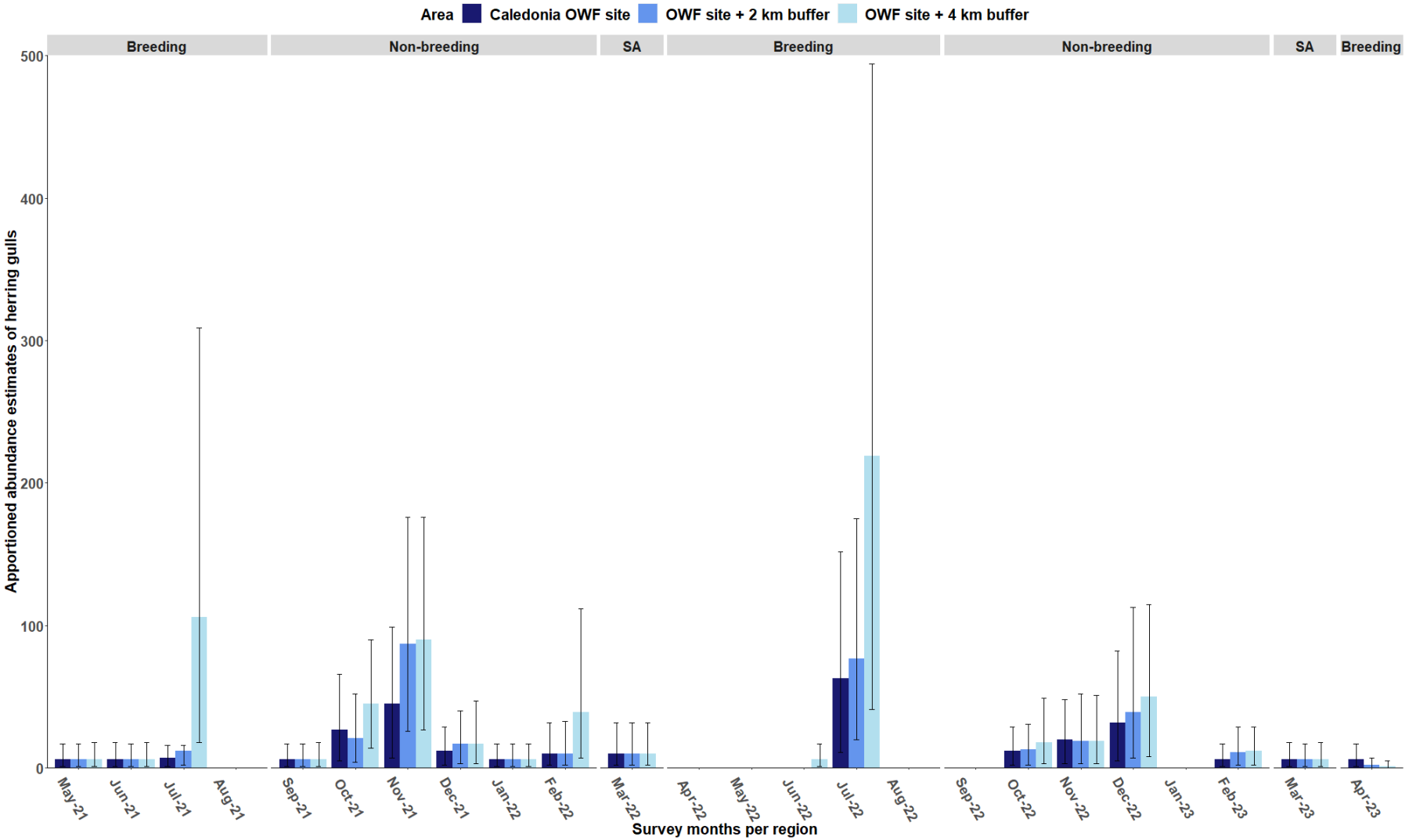



**Figure 10 Bar plot of monthly apportioned abundance estimates (with 95% confidence intervals) of total herring gulls recorded in each reporting region of the Survey Area, during the May 2021 to April 2023 survey period. Herring gull seasonal periods are also displayed. SA stands for breeding site attendance**

### *Caledonia North*

A total of 59 herring gulls were recorded in Caledonia North Survey Area during both years of baseline surveys (Table 9). Herring gulls were recorded in low numbers in Caledonia North Survey Area in May, July, and September to December 2021, February, March, June, July, October to December 2022, and March 2023 (Table 9, Table 33, Figure 11). Herring gulls were the most abundant during the non-breeding season, with peak numbers recorded in October 2021 in Caledonia North, and November 2021 in Caledonia North plus 2 km buffer and Caledonia North Survey Area (Table 33, Figure 11):

- Three individuals were recorded in Caledonia North in October 2021, resulting in an unapportioned mean abundance estimate of 18 [3; 41] and an apportioned mean abundance estimate of 27 [5; 64] individuals. These equated to mean density estimates of 0.08 (unapportioned) and 0.12 (apportioned) birds/km$^2$.
- Eight individuals were recorded in Caledonia North plus 2 km buffer in November 2021, resulting in an unapportioned mean abundance estimate of 46 [8; 91] and an apportioned mean abundance estimate of 48 [11; 104] individuals. These equated to mean density estimates of 0.12 (unapportioned) and 0.13 (apportioned) birds/km$^2$.
- Nine individuals were recorded in Caledonia North Survey Area in November 2021, resulting in an unapportioned mean abundance estimate of 53 [12; 105] and an apportioned mean abundance estimate of 57 [12; 116] individuals. Both equated to a mean density estimate of 0.10 birds/km$^2$.

During the non-breeding seasons covered by the baseline surveys, herring gull numbers peaked in November 2021 and December 2022, with numbers steadily growing each month prior to the peak. Both January to March periods covered by the baseline surveys recorded very low numbers of birds. Birds were completely absent from the surveys on a number of occasions. It is considered that Caledonia North Survey Area is situated is of limited importance to this species during the non-breeding season.

Low numbers of herring gulls were recorded during the breeding season (April to August) in Caledonia North Survey Area. Peak counts were recorded in July 2022 in Caledonia North and Caledonia North plus 2 km buffer, and July 2021 in Caledonia North Survey Area (Table 33, Figure 11):

- Two individuals were recorded in Caledonia North in July 2022, resulting in an unapportioned and apportioned mean abundance estimate of 12 [2; 23] individuals. This equated to a mean density estimate of 0.05 birds/km$^2$.
- Three individuals were recorded in Caledonia North plus 2 km buffer in July 2022, resulting in an unapportioned mean abundance estimate of 17 [3; 34], and apportioned mean abundance estimate of 17 [6; 34] individuals. Both equated to a mean density estimate of 0.05 birds/km$^2$.
- 16 individuals were recorded in Caledonia North Survey Area, resulting in an unapportioned mean abundance estimate of 97 [16; 291] and an apportioned mean abundance estimate of 108 [18; 319] individuals. These equated to mean density estimates of 0.17 (unapportioned) and 0.19 (apportioned) birds/km$^2$.

In both breeding seasons covered by the baseline surveys, apportioned mean herring gull abundances across Caledonia North Survey Area were very low between April to June, with larger (though still modest) numbers of birds present in July. Birds were absent in August 2021 and 2022. This indicates that the area in which Caledonia Survey Area is situated is of limited importance to this species during the breeding season.

Measures of precisions were high (indicating lower levels of precision), which is likely related to the low numbers of individuals recorded in each reporting region during each survey (CV > 0.16; Table 33).

**Table 33** **Raw counts, unapportioned and apportioned abundance and density estimates (birds per km$^2$) of herring gulls in Caledonia North, Caledonia North plus 2 km buffer and Caledonia North Survey Area during the May 2021 to April 2023 survey period. Colour gradients follow the ascending order of herring gull raw counts per season, with light yellow to orange (peak number) for the breeding season months (April to August) and light blue to royal blue (peak number) for the wintering months (September to March)**

| Survey | Raw count | Total unapportioned | | | | | Total apportioned | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Abundance | LCL | UCL | Precision (CV) | Density (km$^2$) | Abundance | LCL | UCL | Density (km$^2$) |
| **a) Caledonia North** | | | | | | | | | | |
| May-21 | 1 | 6 | 1 | 17 | 1.00 | 0.03 | 6 | 1 | 17 | 0.03 |
| Jul-21 | - | - | - | - | - | - | 12 | 2 | 30 | 0.05 |
| Sep-21 | 1 | 6 | 1 | 17 | 1.00 | 0.03 | 6 | 1 | 17 | 0.03 |
| Oct-21 | 3 | 18 | 3 | 41 | 0.58 | 0.08 | 27 | 5 | 64 | 0.12 |
| Nov-21 | 1 | 6 | 1 | 18 | 1.00 | 0.03 | 7 | 1 | 21 | 0.03 |
| Dec-21 | 2 | 12 | 2 | 23 | 0.71 | 0.05 | 12 | 2 | 23 | 0.05 |
| Feb-22 | 1 | 5 | 1 | 16 | 1.00 | 0.02 | 5 | 1 | 16 | 0.02 |
| Mar-22 | 1 | 5 | 1 | 16 | 1.00 | 0.02 | 5 | 1 | 16 | 0.02 |
| Jul-22 | 2 | 12 | 2 | 23 | 0.71 | 0.05 | 12 | 2 | 23 | 0.05 |
| Oct-22 | 1 | 6 | 1 | 17 | 1.00 | 0.03 | 6 | 1 | 17 | 0.03 |
| Dec-22 | 1 | 6 | 1 | 17 | 1.00 | 0.03 | 6 | 1 | 17 | 0.03 |
| Mar-23 | 1 | 6 | 1 | 18 | 1.00 | 0.03 | 6 | 1 | 18 | 0.03 |
| **b) Caledonia North plus 2 km buffer** | | | | | | | | | | |
| May-21 | 1 | 6 | 1 | 17 | 1.00 | 0.02 | 6 | 1 | 17 | 0.02 |
| Jul-21 | - | - | - | - | - | - | 12 | 2 | 29 | 0.03 |
| Sep-21 | 1 | 6 | 1 | 17 | 1.00 | 0.02 | 6 | 1 | 17 | 0.02 |
| Oct-21 | 3 | 17 | 3 | 40 | 0.58 | 0.05 | 20 | 4 | 52 | 0.05 |
| Nov-21 | 8 | 46 | 8 | 91 | 0.35 | 0.12 | 48 | 11 | 104 | 0.13 |
| Dec-21 | 2 | 11 | 2 | 28 | 0.71 | 0.03 | 11 | 2 | 28 | 0.03 |
| Feb-22 | 1 | 5 | 1 | 16 | 1.00 | 0.01 | 5 | 1 | 17 | 0.01 |
| Mar-22 | 1 | 5 | 1 | 16 | 1.00 | 0.01 | 5 | 1 | 16 | 0.01 |
| Jul-22 | 3 | 17 | 3 | 34 | 0.58 | 0.05 | 17 | 6 | 34 | 0.05 |
| Oct-22 | 1 | 6 | 1 | 18 | 1.00 | 0.02 | 7 | 1 | 21 | 0.02 |
| Dec-22 | 4 | 24 | 4 | 59 | 0.50 | 0.06 | 27 | 5 | 73 | 0.07 |
| Mar-23 | 1 | 6 | 1 | 17 | 1.00 | 0.02 | 6 | 1 | 17 | 0.02 |
| **c) Caledonia North Survey Area** | | | | | | | | | | |
| May-21 | 1 | 6 | 1 | 18 | 1.00 | 0.01 | 6 | 1 | 18 | 0.01 |
| Jul-21 | 16 | 97 | 16 | 291 | 0.25 | 0.17 | 108 | 18 | 319 | 0.19 |
| Sep-21 | 1 | 6 | 1 | 18 | 1.00 | 0.01 | 6 | 1 | 18 | 0.01 |
| Oct-21 | 7 | 41 | 18 | 70 | 0.38 | 0.07 | 45 | 14 | 90 | 0.08 |
| Nov-21 | 9 | 53 | 12 | 105 | 0.33 | 0.10 | 57 | 12 | 116 | 0.10 |
| Dec-21 | 2 | 12 | 2 | 29 | 0.71 | 0.02 | 12 | 2 | 29 | 0.02 |
| Feb-22 | 1 | 6 | 1 | 17 | 1.00 | 0.01 | 6 | 1 | 18 | 0.01 |
| Mar-22 | 1 | 5 | 1 | 16 | 1.00 | 0.01 | 10 | 2 | 32 | 0.02 |
| Jun-22 | 1 | 6 | 1 | 17 | 1.00 | 0.01 | 6 | 1 | 17 | 0.01 |
| Jul-22 | 12 | 70 | 12 | 181 | 0.29 | 0.13 | 71 | 15 | 193 | 0.13 |
| Oct-22 | 1 | 6 | 1 | 18 | 1.00 | 0.01 | 6 | 1 | 20 | 0.01 |
| Nov-22 | 1 | 6 | 1 | 18 | 1.00 | 0.01 | 6 | 1 | 18 | 0.01 |
| Dec-22 | 5 | 29 | 5 | 71 | 0.45 | 0.05 | 32 | 5 | 76 | 0.06 |
| Mar-23 | 1 | 6 | 1 | 18 | 1.00 | 0.01 | 6 | 1 | 18 | 0.01 |

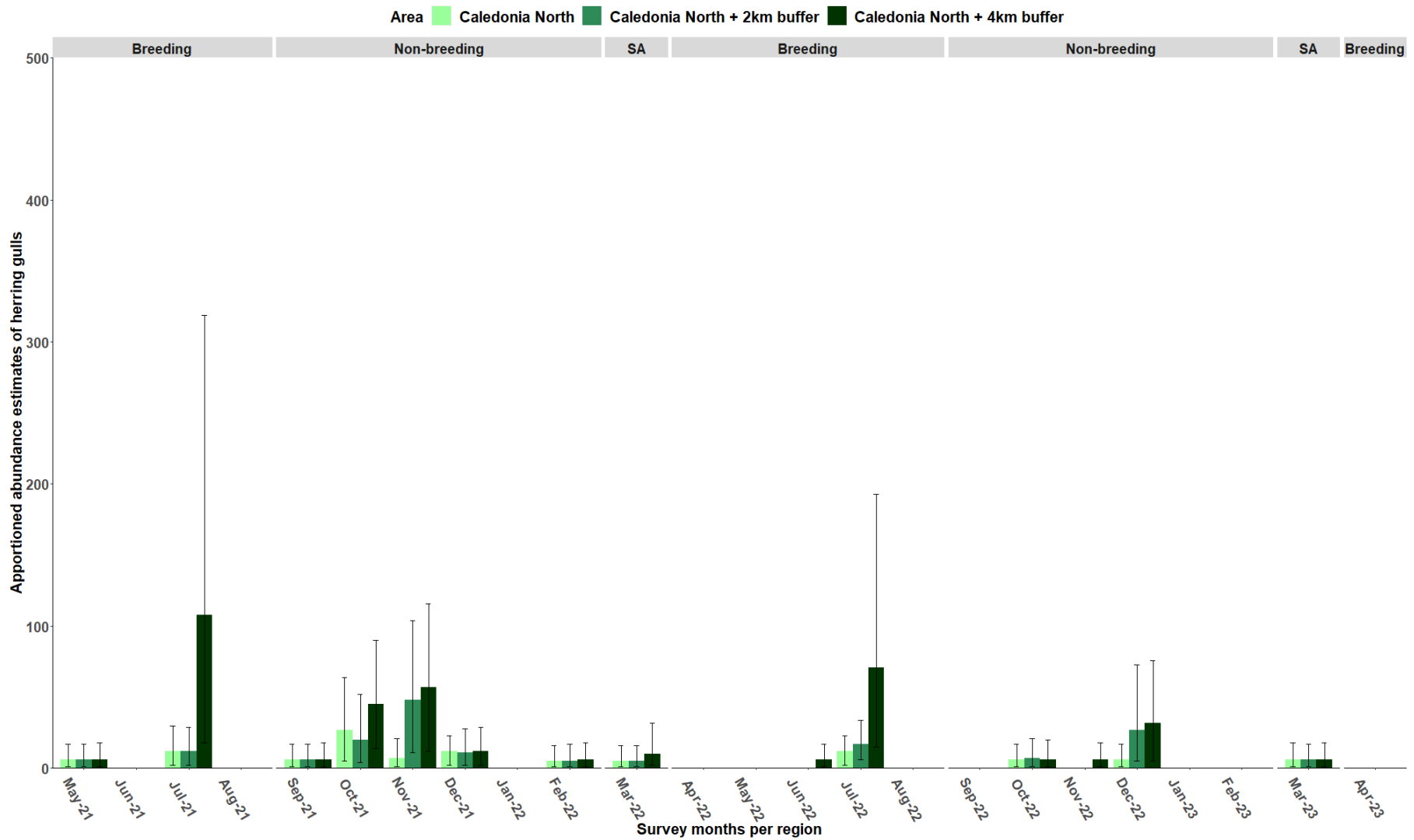



**Figure 11 Bar plot of monthly apportioned abundance estimates (with 95% confidence intervals) of the total herring gulls recorded in each reporting region of Caledonia North Survey Area, during the May 2021 to April 2023 survey period. Herring gull seasonal periods are also displayed. SA stands for breeding site attendance**

### *Caledonia South*

A total of 60 herring gulls were recorded in Caledonia South Survey Area during both years of baseline surveys (Table 10). Herring gulls were recorded in low numbers in Caledonia South Survey Area in June 2021, November 2021 to February 2022, July 2022, October to December 2022 and February 2023 (Table 10, Table 34, Figure 12). Herring gulls were the more abundant during the non-breeding season (Table 34). Peak numbers were recorded in November 2021 (Table 34, Figure 12):

- Six individuals were recorded in Caledonia South, resulting in an unapportioned mean abundance estimate of 35 [6; 81] and an apportioned mean abundance estimate of 39 [7; 93] individuals. These equated to mean density estimates of 0.17 (unapportioned) and 0.19 (apportioned) birds/km$^2$.
- Eight individuals were recorded in Caledonia South plus 2 km buffer, resulting in an unapportioned mean abundance estimate of 46 [8; 97] and an apportioned mean abundance estimate of 51 [14; 121] individuals. These equated to mean density estimates of 0.13 (unapportioned) and 0.14 (apportioned) birds/km$^2$.
- Eight individuals were recorded in Caledonia South Survey Area, resulting in an unapportioned mean abundance estimate of 46 [8; 98] and an apportioned mean abundance estimate of 51 [9; 120] individuals. These equated to mean density estimates of 0.09 (unapportioned) and 0.10 (apportioned) birds/km$^2$.

During the non-breeding seasons covered by the baseline surveys, herring gull numbers peaked in November 2021 and December 2022. Both January to March periods covered by the baseline surveys recorded very low numbers of birds. Birds were completely absent from the surveys on a number of occasions. It is considered that Caledonia South Survey Area is situated is of limited importance to this species during the non-breeding season.

Herring gulls were the most abundant during the breeding season in Caledonia South and Caledonia South plus 2 km buffer (n≤8) while a peak number was recorded in July 2022 in Caledonia South Survey Area (Table 34, Figure 11):

- Four individuals were recorded in Caledonia South, resulting in an unapportioned mean abundance estimate of 23 [4; 70] and an apportioned mean abundance estimate of 47 [8; 137] individuals. These equated to mean density estimates of 0.11 (unapportioned) and 0.22 (apportioned) birds/km$^2$.
- Six individuals were recorded in Caledonia South plus 2 km buffer, resulting in an unapportioned mean abundance estimate of 35 [6; 87] and an apportioned mean abundance estimate of 70 [41; 168] individuals. These equated to mean density estimates of 0.10 (unapportioned) and 0.19 (apportioned) birds/km$^2$.
- 28 individuals in Caledonia South Survey Area, resulting in an unapportioned mean abundance estimate of 162 [41; 307] and an apportioned mean abundance estimate of 208 [36; 465] individuals. These equated to mean density estimates of 0.30 (unapportioned) and 0.39 (apportioned) birds/km$^2$.

In both breeding seasons covered by the baseline surveys, apportioned mean herring gull abundances across Caledonia South Survey Area were very low between April to June, with larger (though still modest) numbers of birds present in July 2022 (though not July 2021). Birds were absent in August 2021 and 2022. This indicates that the area in which Caledonia Survey Area is situated is of limited importance to this species during the breeding season.

Measures of precisions were high (indicating lower levels of precision), which is likely related to the low numbers of individuals recorded in each reporting region during each survey (CV > 0.16; Table 34).

**Table 34** **Raw counts, unapportioned and apportioned abundance and density estimates (birds per km$^2$) of herring gulls in Caledonia South, Caledonia South plus 2 km buffer and Caledonia South Survey Area during the May 2021 to April 2023 survey period. Colour gradients follow the ascending order of herring gull raw counts per season, with light yellow to orange (peak number) for the breeding season months (April to August) and light blue to royal blue (peak number) for the wintering months (September to March)**

| Survey | Raw count | Total unapportioned | | | | | Total apportioned | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Abundance | LCL | UCL | Precision (CV) | Density (km$^2$) | Abundance | LCL | UCL | Density (km$^2$) |
| **a) Caledonia South** | | | | | | | | | | |
| **Jun-21** | 1 | 6 | 1 | 17 | 1.00 | 0.03 | 6 | 1 | 17 | 0.03 |
| **Nov-21** | **6** | **35** | **6** | **81** | **0.41** | **0.17** | **39** | **7** | **93** | **0.19** |
| **Jan-22** | 1 | 6 | 1 | 17 | 1.00 | 0.03 | 6 | 1 | 17 | 0.03 |
| **Feb-22** | 1 | 5 | 1 | 16 | 1.00 | 0.02 | 5 | 1 | 16 | 0.02 |
| **Jul-22** | **4** | **23** | **4** | **70** | **0.50** | **0.11** | **47** | **8** | **137** | **0.22** |
| **Oct-22** | 1 | 6 | 1 | 18 | 1.00 | 0.03 | 6 | 1 | 18 | 0.03 |
| **Nov-22** | 3 | 18 | 6 | 35 | 0.58 | 0.09 | 22 | 4 | 52 | 0.11 |
| **Dec-22** | 4 | 24 | 4 | 71 | 0.50 | 0.11 | 26 | 4 | 77 | 0.13 |
| **Feb-23** | 1 | 6 | 1 | 17 | 1.00 | 0.03 | 6 | 1 | 17 | 0.03 |
| **b) Caledonia South plus 2 km buffer** | | | | | | | | | | |
| **Jun-21** | 1 | 6 | 1 | 17 | 1.00 | 0.02 | 6 | 1 | 17 | 0.02 |
| **Oct-21** | - | - | - | - | - | - | 1 | 1 | 2 | 0.00 |
| **Nov-21** | **8** | **46** | **8** | **97** | **0.35** | **0.13** | **51** | **14** | **121** | **0.14** |
| **Dec-21** | 2 | 12 | 2 | 29 | 0.71 | 0.03 | 12 | 2 | 29 | 0.03 |
| **Jan-22** | 1 | 6 | 1 | 17 | 1.00 | 0.02 | 6 | 1 | 17 | 0.02 |
| **Feb-22** | 1 | 5 | 1 | 16 | 1.00 | 0.01 | 5 | 1 | 16 | 0.01 |
| **Jul-22** | **6** | **35** | **6** | **87** | **0.41** | **0.10** | **70** | **41** | **168** | **0.19** |
| **Oct-22** | 2 | 12 | 2 | 29 | 0.71 | 0.03 | 12 | 2 | 34 | 0.03 |
| **Nov-22** | 3 | 17 | 3 | 35 | 0.58 | 0.05 | 19 | 4 | 44 | 0.05 |
| **Dec-22** | 5 | 29 | 5 | 87 | 0.45 | 0.08 | 31 | 7 | 93 | 0.09 |
| **Feb-23** | 2 | 11 | 2 | 29 | 0.71 | 0.03 | 11 | 2 | 29 | 0.03 |
| **c) Caledonia South Survey Area** | | | | | | | | | | |
| **Jun-21** | 1 | 6 | 1 | 17 | 1.00 | 0.01 | 6 | 1 | 17 | 0.01 |
| **Jul-21** | - | - | - | - | - | - | 4 | 1 | 10 | 0.01 |
| **Nov-21** | **8** | **46** | **8** | **98** | **0.35** | **0.09** | **51** | **9** | **120** | **0.10** |
| **Dec-21** | 2 | 12 | 2 | 29 | 0.71 | 0.02 | 12 | 2 | 29 | 0.02 |
| **Jan-22** | 1 | 6 | 1 | 17 | 1.00 | 0.01 | 6 | 1 | 17 | 0.01 |
| **Feb-22** | 7 | 38 | 7 | 98 | 0.38 | 0.07 | 38 | 7 | 103 | 0.07 |
| **Jul-22** | **28** | **162** | **41** | **307** | **0.19** | **0.30** | **208** | **36** | **465** | **0.39** |
| **Oct-22** | 2 | 12 | 2 | 23 | 0.71 | 0.02 | 12 | 2 | 36 | 0.02 |
| **Nov-22** | 3 | 18 | 3 | 35 | 0.58 | 0.03 | 19 | 3 | 52 | 0.04 |
| **Dec-22** | 6 | 35 | 6 | 94 | 0.41 | 0.07 | 38 | 6 | 106 | 0.07 |
| **Feb-23** | 2 | 12 | 2 | 29 | 0.71 | 0.02 | 12 | 2 | 29 | 0.02 |

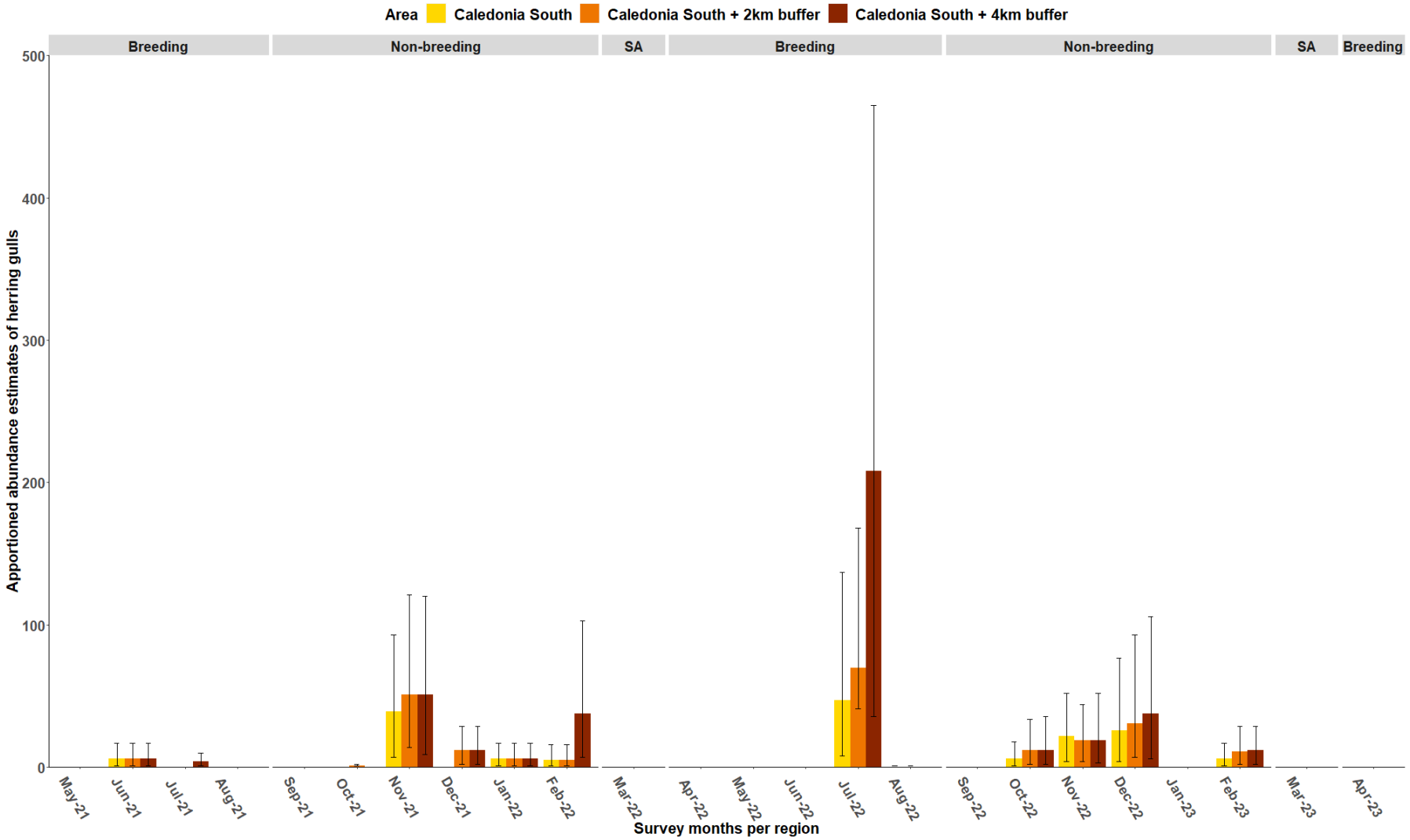



**Figure 12 Bar plot of monthly apportioned abundance estimates (with 95% confidence intervals) of the total herring gulls recorded in each reporting region of Caledonia South Survey Area, during the May 2021 to April 2023 survey period. Herring gull seasonal periods are also displayed. SA stands for breeding site attendance**

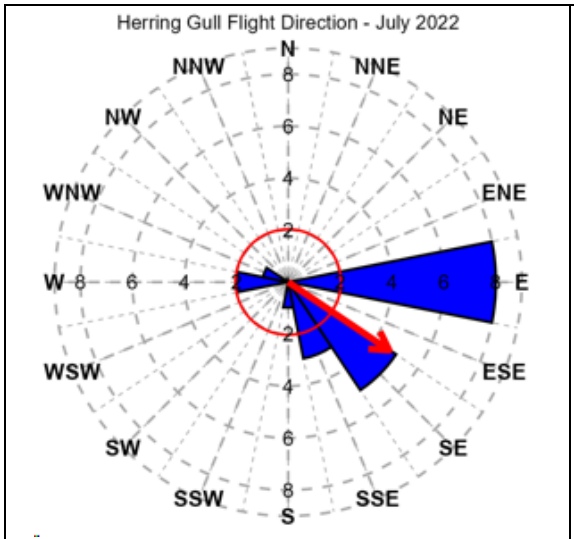
### *ii. Distribution and behaviour*

Maps of distribution are shown in Appendix 4: Figures A4.48-64. Herring gulls were recorded in the north of Caledonia North in May 2021, March 2022 and 2023 (Figures A4.48, 57, 64) whereas they were recorded in Caledonia South in January 2022 (Figure A4.55). In June 2021, a single alive individual was recorded in Caledonia South and a deceased individual was recorded in Caledonia North (Figure A4.49). During July, September, and October 2021, and June 2022, they were concentrated in the west of Caledonia North, where individuals largely occurred within the Buffer Zone (Figures A4.50-52, 58). Herring gulls were loosely distributed across central parts of Caledonia OWF and Buffer Zone between November and December 2021 as well as December 2022 (Figures A4.53-54, 62). A more southern distribution was recorded in February 2022 and 2023, July, October, and November 2022 (Figure A4.56, 59-61, 63) (Figure A4.63).

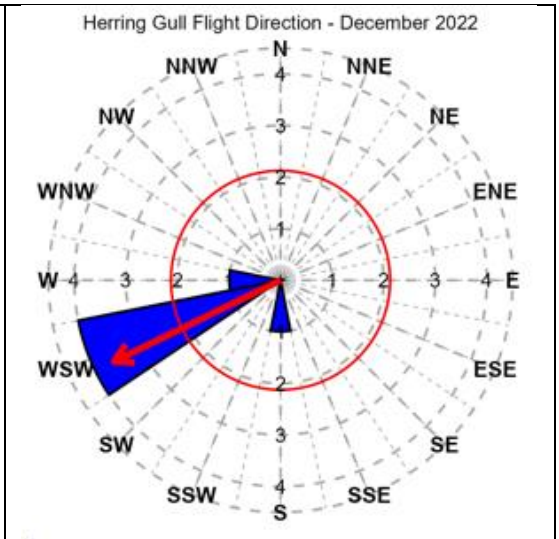
Significant predominant direction of flight was recorded in:

- **July**
  - 2022 southeast (Figure 13a)
- **December**
  - 2022 west-southwest (Figure 13b)

As very few birds were recorded in flight in other surveys, they were too infrequent to determine any preference in flight direction (Appendix 5, Figure A5.7).




| Number of Observations | 20 |
|---|---|
| Mean Vector (μ) | 124.391 |
| Length of Mean Vector (r) | 0.586 |
| Rayleigh Test (Z) | 6.877 |
| Rayleigh Test (p) | <0.001 |
| **a July 2022** | |




| Number of Observations | 6 |
|---|---|
| Mean Vector (μ) | 244.054 |
| Length of Mean Vector (r) | 0.897 |
| Rayleigh Test (Z) | 4.831 |
| Rayleigh Test (p) | 0.003 |
| **b December 2022** | |

**Figure 13 Summary of flight direction of herring gulls within surveys where a significant flight direction was recorded during the May 2021 to April 2023 survey period**

## 4.8 Lesser black-backed gull

### *i. Abundance and density estimates*

A total of 12 lesser black-backed gulls were recorded in the Survey Area during both years of baseline surveys (Table 8). Individuals were only recorded during the breeding season (mid-March to August), in July 2021 and May to July 2022 (Table 35). Peak numbers were recorded in July 2022 across the Survey Area, with four individuals recorded in Caledonia OWF and Caledonia OWF plus 2 km buffer, and six individuals recorded in the Survey Area (Table 35). The latter resulted in an unapportioned mean abundance estimate of 35 [6; 94] and an apportioned mean abundance estimate of 56 [9; 184] individuals. These equated to mean density estimates of 0.04 (unapportioned) and 0.06 (apportioned) birds/km$^2$ (Table 35).

The very low number of lesser black-backed gulls recorded within the Survey Area in both years of surveys indicates a lack of connectivity between the area of sea, in which Caledonia OWF is situated, and the single SPA breeding colony of this species (Forth Islands SPA), which was identified by the HRA Screening Report (GoBe Consultants, 2022) as potentially having connectivity with Caledonia OWF during the breeding season.

Measures of precisions were high (indicating lower levels of precision), which is likely related to the low numbers of individuals recorded in each reporting region during each survey (CV > 0.16; Table 35).

**Table 35 Raw counts, unapportioned and apportioned abundance and density estimates (birds per km$^2$) of lesser black-backed gulls in Caledonia OWF, Caledonia OWF plus 2 km buffer and the Survey Area during the May 2021 to April 2023 survey period**

| Survey | Raw count | Total unapportioned | | | | | Total apportioned | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Abundance | LCL | UCL | Precision (CV) | Density (km$^2$) | Abundance | LCL | UCL | Density (km$^2$) |
| **a) Caledonia OWF** | | | | | | | | | | |
| **Jul-21** | 0 | - | - | - | - | - | 5 | 1 | 13 | 0.01 |
| **Jun-22** | 2 | 11 | 2 | 34 | 0.71 | 0.03 | 11 | 2 | 34 | 0.03 |
| **Jul-22** | 4 | 23 | 4 | 70 | 0.50 | 0.05 | 42 | 7 | 129 | 0.1 |
| **b) Caledonia OWF plus 2 km buffer** | | | | | | | | | | |
| **Jul-21** | 0 | - | - | - | - | - | 4 | 1 | 13 | 0.01 |
| **Jun-22** | 2 | 11 | 2 | 34 | 0.71 | 0.02 | 11 | 2 | 34 | 0.02 |
| **Jul-22** | 4 | 23 | 4 | 69 | 0.50 | 0.04 | 44 | 7 | 141 | 0.07 |
| **c) Survey Area** | | | | | | | | | | |
| **Jul-21** | 3 | 18 | 3 | 48 | 0.58 | 0.02 | 28 | 5 | 84 | 0.03 |
| **May-22** | 1 | 6 | 1 | 17 | <1 | 0.01 | 6 | 1 | 17 | 0.01 |
| **Jun-22** | 2 | 12 | 2 | 35 | 0.71 | 0.01 | 12 | 2 | 35 | 0.01 |
| **Jul-22** | 6 | 35 | 6 | 94 | 0.41 | 0.04 | 56 | 9 | 184 | 0.06 |

Six lesser black-backed gulls were recorded in Caledonia North Survey Area (Table 9). In Caledonia North and Caledonia North plus 2 km buffer, two individuals were recorded in June 2022 (Table 36). However, peak numbers were recorded in July 2021 in Caledonia North Survey Area with three individuals recorded. The latter resulted in an unapportioned mean abundance estimate of 18 [3; 48] and an apportioned mean abundance estimate of 25 [4; 75] individuals, which equated to mean density estimates of 0.03 (unapportioned) and 0.05 (apportioned) birds/km$^2$ (Table 36).

Measures of precisions were high (indicating lower levels of precision), which is likely related to the low numbers of individuals recorded in each reporting region during each survey (CV > 0.16; Table 36 and Table 37).

**Table 36 Raw counts, unapportioned and apportioned abundance and density estimates (birds per km$^2$) of lesser black-backed gulls in Caledonia North, Caledonia North plus 2 km buffer and Caledonia North Survey Area during the May 2021 to April 2023 survey period**

| Survey | Raw count | Total unapportioned | | | | | Total apportioned | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Abundance | LCL | UCL | Precision (CV) | Density (km$^2$) | Abundance | LCL | UCL | Density (km$^2$) |
| **a) Caledonia North** | | | | | | | | | | |
| **Jun-22** | 2 | 11 | 2 | 34 | 0.71 | 0.05 | 11 | 2 | 34 | 0.05 |
| **b) Caledonia North plus 2 km buffer** | | | | | | | | | | |
| **Jun-22** | 2 | 12 | 2 | 35 | 0.71 | 0.04 | 12 | 2 | 35 | 0.03 |
| **c) Caledonia North Survey Area** | | | | | | | | | | |
| **Jul-21** | 3 | 18 | 3 | 48 | 0.58 | 0.03 | 25 | 4 | 75 | 0.05 |
| **May-22** | 1 | 6 | 1 | 17 | 1.00 | 0.01 | 6 | 1 | 17 | 0.01 |
| **Jun-22** | 2 | 12 | 2 | 35 | 0.71 | 0.02 | 12 | 2 | 35 | 0.02 |

Six lesser black-backed gulls were recorded in Caledonia South Survey Area (Table 10). In Caledonia South and Caledonia South plus 2 km buffer, four individuals were recorded in July 2022 (Table 37). However, peak numbers were recorded in July 2022 in Caledonia South Survey Area with six individuals recorded. The latter resulted in an unapportioned mean abundance estimate of 35 [6; 93] and an apportioned mean abundance estimate of 58 [10; 190] individuals, which equated to mean density estimates of 0.07 (unapportioned) and 0.11 (apportioned) birds/km$^2$ (Table 37).

**Table 37 Raw counts, unapportioned and apportioned abundance and density estimates (birds per km$^2$) of lesser black-backed gulls in Caledonia South, Caledonia South plus 2 km buffer and Caledonia South Survey Area during the May 2021 to April 2023 survey period**

| Survey | Raw count | Total unapportioned | | | | | Total apportioned | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Abundance | LCL | UCL | Precision (CV) | Density (km$^2$) | Abundance | LCL | UCL | Density (km$^2$) |
| **a) Caledonia South** | | | | | | | | | | |
| **Jul-22** | 4 | 23 | 4 | 70 | 0.50 | 0.11 | 47 | 8 | 137 | 0.22 |
| **Aug-22** | - | - | - | - | - | - | - | - | 1 | - |
| **b) Caledonia South plus 2 km buffer** | | | | | | | | | | |
| **Jul-22** | 4 | 23 | 4 | 69 | 0.50 | 0.06 | 46 | 27 | 144 | 0.13 |
| **Aug-22** | - | - | - | - | - | - | - | - | 1 | - |
| **c) Caledonia South Survey Area** | | | | | | | | | | |
| **Jul-21** | - | - | - | - | - | - | 2 | - | 8 | 0.00 |
| **Jul-22** | 6 | 35 | 6 | 93 | 0.41 | 0.07 | 58 | 10 | 190 | 0.11 |

### *ii. Distribution and behaviour*

Maps of distribution are shown in Appendix 4: Figure A4.65-68. In July 2021, lesser black-backed gulls were recorded in the west of Caledonia North Buffer Zone, towards the southern end of the area occupied by Moray East wind turbines (Figure A4.65). A single individual occurred in the northeast of Caledonia North Buffer Zone in May 2022 (Figure A4.66), while two lesser black-backed gulls were recorded at the northern tip of Caledonia North in June 2022 (Figure A4.67). In contrast, individuals were concentrated in the southwest of the Survey Area, in southwest of Caledonia South and within the Buffer Zone (Figure A4.68).

As very few birds were recorded in flight, they were too infrequent to determine any preference in flight direction (Appendix 5, Figure A5.8).

## 4.9 Unidentified black-backed gull species

### *i. Abundance and density estimates*

Three black-backed gulls that could not be identified to species level were recorded in the Survey Area during both years of baseline surveys, with two individuals in Caledonia North Survey Area and a single individual in Caledonia South (Table 8 to Table 10). Abundance and density estimates are therefore very low. Black-backed gull species have been used for apportioning to species level where possible.

**Table 38 Raw counts, unapportioned abundance and density estimates (birds per km²) of black-backed gull species in Caledonia OWF, Caledonia OWF plus 2 km buffer and the Survey Area during the May 2021 to April 2023 survey period**

| Survey | Raw count | Total unapportioned | | | | |
|---|---|---|---|---|---|---|
| | | Abundance | LCL | UCL | Precision (CV) | Density (km²) |
| **a) Caledonia OWF** | | | | | | |
| **Nov-21** | 1 | 6 | 1 | 17 | <1 | 0.01 |
| **b) Caledonia OWF plus 2 km buffer** | | | | | | |
| **Nov-21** | 2 | 11 | 2 | 29 | 0.71 | 0.02 |
| **c) Survey Area** | | | | | | |
| **Jul-21** | 1 | 6 | 1 | 18 | <1 | 0.01 |
| **Nov-21** | 2 | 12 | 2 | 29 | 0.71 | 0.01 |

**Table 39 Raw counts, unapportioned abundance and density estimates (birds per km²) of black-backed gull species in Caledonia North, Caledonia North plus 2 km buffer and Caledonia North Survey Area during the May 2021 to April 2023 survey period**

| Survey | Raw count | Total unapportioned | | | | |
|---|---|---|---|---|---|---|
| | | Abundance | LCL | UCL | Precision (CV) | Density (km²) |
| **a) Caledonia North** | | | | | | |
| None recorded | | | | | | |
| **b) Caledonia North plus 2 km buffer** | | | | | | |
| **Nov-21** | 1 | 6 | 1 | 17 | <1 | 0.02 |
| **c) Caledonia North Survey Area** | | | | | | |
| **Jul-21** | 1 | 6 | 1 | 18 | <1 | 0.01 |
| **Nov-21** | 1 | 6 | 1 | 18 | <1 | 0.01 |

**Table 40 Raw counts, unapportioned abundance and density estimates (birds per km²) of black-backed gull species in Caledonia South, Caledonia South plus 2 km buffer and Caledonia South Survey Area during the May 2021 to April 2023 survey period**

| Survey | Raw count | Total unapportioned | | | | |
|---|---|---|---|---|---|---|
| | | Abundance | LCL | UCL | Precision (CV) | Density (km²) |
| **a) Caledonia South** | | | | | | |
| **Nov-21** | 1 | 6 | 1 | 17 | 1.00 | 0.03 |
| **b) Caledonia South plus 2 km buffer** | | | | | | |
| **Nov-21** | 1 | 6 | 1 | 17 | 1.00 | 0.02 |
| **c) Caledonia South Survey Area** | | | | | | |
| **Nov-21** | 1 | 6 | 1 | 17 | 1.00 | 0.01 |

### *ii. Distribution and behaviour*

A single black-backed gull species was recorded in the west of the Survey Area towards the outer Buffer Zone boundary of Caledonia North Survey Area just north of the subdivision line during July 2021 (Appendix 4, Figure A4.69). In November 2021, one individual was recorded in the west of Caledonia North Buffer Zone near the Caledonia North boundary while the second individual was recorded in the east of Caledonia South (Appendix 4, Figure A4.70).

As only one bird was recorded in flight, they were too infrequent to determine any preference in flight direction (Appendix 5, Figure A5.9).

### 4.10 Unidentified large gull species

#### *i. Abundance and density estimates*

A total of 44 unidentified large gulls were recorded in the Survey Area during both years of baseline surveys (Table 8). Large gull species were recorded in the July, September to November 2021, January, March, July and October to November 2022, and April 2023 (Table 8, Table 41). The peak raw count was recorded in November 2021 in all reporting regions. In the Survey Area, 16 individuals were recorded in November 2021, resulting in an unapportioned mean abundance estimate of 93 individuals, which equated to a mean density estimate of 0.11 birds/km$^2$ (Table 41). Large gull species have been used for apportioning to species level where possible.

Measures of precisions were high, which is likely related to the low numbers of individuals recorded in each region (CV > 0.16; Table 41).

**Table 41 Raw counts, unapportioned abundance and density estimates (birds per km$^2$) of large gull species in Caledonia OWF, Caledonia OWF plus 2 km buffer and the Survey Area during the May 2021 to April 2023 survey period**

| Survey | Raw count | Total unapportioned | | | | |
|---|---|---|---|---|---|---|
| | | Abundance | LCL | UCL | Precision (CV) | Density (km$^2$) |
| **a) Caledonia OWF** | | | | | | |
| **Jul-21** | 2 | 12 | 2 | 29 | 0.71 | 0.03 |
| **Sep-21** | 2 | 12 | 2 | 29 | 0.71 | 0.03 |
| **Oct-21** | 4 | 23 | 4 | 47 | 0.50 | 0.05 |
| **Nov-21** | 8 | 46 | 8 | 93 | 0.35 | 0.11 |
| **Mar-22** | 1 | 5 | 1 | 16 | <1 | 0.01 |
| **Jul-22** | 8 | 47 | 8 | 129 | 0.35 | 0.11 |
| **Nov-22** | 1 | 6 | 1 | 18 | <1 | 0.01 |
| **Apr-23** | 1 | 6 | 1 | 17 | <1 | 0.01 |
| **b) Caledonia OWF plus 2 km buffer** | | | | | | |
| **Jul-21** | 2 | 12 | 2 | 29 | 0.71 | 0.02 |
| **Sep-21** | 3 | 17 | 3 | 34 | 0.58 | 0.03 |
| **Oct-21** | 5 | 29 | 6 | 58 | 0.45 | 0.05 |
| **Nov-21** | 12 | 69 | 17 | 126 | 0.29 | 0.11 |
| **Jan-22** | 1 | 6 | 1 | 17 | <1 | 0.01 |
| **Mar-22** | 1 | 5 | 1 | 16 | <1 | 0.01 |
| **Jul-22** | 10 | 58 | 10 | 167 | 0.32 | 0.09 |
| **Oct-22** | 1 | 6 | 1 | 17 | <1 | 0.01 |
| **Nov-22** | 1 | 6 | 1 | 17 | <1 | 0.01 |
| **Apr-23** | 1 | 6 | 1 | 17 | <1 | 0.01 |
| **c) Survey Area** | | | | | | |
| **Jul-21** | 2 | 12 | 2 | 30 | 0.71 | 0.01 |
| **Sep-21** | 4 | 23 | 6 | 41 | 0.50 | 0.03 |
| **Oct-21** | 5 | 29 | 6 | 59 | 0.45 | 0.03 |
| **Nov-21** | 16 | 93 | 47 | 151 | 0.25 | 0.11 |
| **Jan-22** | 1 | 6 | 1 | 17 | <1 | 0.01 |
| **Mar-22** | 1 | 5 | 1 | 16 | <1 | 0.01 |
| **Jul-22** | 12 | 70 | 12 | 205 | 0.29 | 0.08 |
| **Oct-22** | 1 | 6 | 1 | 18 | <1 | 0.01 |
| **Nov-22** | 1 | 6 | 1 | 18 | <1 | 0.01 |
| **Apr-23** | 1 | 6 | 1 | 17 | <1 | 0.01 |

In Caledonia North Survey Area, large gulls were similarly recorded to the wider Survey Area, except in July and November 2022, and April 2023, where individuals were recorded in Caledonia South Survey Area (Table 9,Table 10). Large gulls were absent from Caledonia South Survey Area in September 2021, January and October 2022 (Table 9, Table 10).

Across Caledonia North Survey Area, peak numbers were recorded in October 2021, with four individuals in Caledonia North and five individuals in Caledonia North plus buffers (Table 42). In Caledonia North Survey Area, this resulted in an unapportioned mean abundance estimate of 29 [6; 41] individuals, which equated to a mean density estimate of 0.05 birds/km$^2$ (Table 42).

In Caledonia South, peak numbers were recorded in July 2022, with eight individuals, while a peak number of ten individuals was recorded in November 2021 and July 2022 in Caledonia South plus 2 km buffer (Table 43). In Caledonia South Survey Area, a peak number of 14 individuals was recorded in November 2021. This resulted in an unapportioned mean abundance estimate of 80 [34;144] individuals, which equated to a mean density estimate of 0.15 birds/km$^2$ (Table 43).

**Table 42 Raw counts, unapportioned abundance and density estimates (birds per km$^2$) of large gull species in Caledonia North, Caledonia North plus 2 km buffer and Caledonia North Survey Area during the May 2021 to April 2023 survey period**

| Survey | Raw count | Total unapportioned | | | | |
|---|---|---|---|---|---|---|
| | | Abundance | LCL | UCL | Precision (CV) | Density (km$^2$) |
| **a) Caledonia North** | | | | | | |
| **Jul-21** | 2 | 12 | 2 | 30 | 0.71 | 0.05 |
| **Sep-21** | 2 | 12 | 2 | 23 | 0.71 | 0.05 |
| **Oct-21** | 4 | 23 | 6 | 47 | 0.50 | 0.11 |
| **Nov-21** | 1 | 6 | 1 | 18 | <1 | 0.03 |
| **b) Caledonia North plus 2 km buffer** | | | | | | |
| **Jul-21** | 2 | 12 | 2 | 23 | 0.71 | 0.03 |
| **Sep-21** | 3 | 17 | 6 | 34 | 0.58 | 0.05 |
| **Oct-21** | 5 | 29 | 6 | 51 | 0.45 | 0.08 |
| **Nov-21** | 4 | 23 | 4 | 57 | 0.50 | 0.06 |
| **Jan-22** | 1 | 6 | 1 | 17 | <1 | 0.02 |
| **Oct-22** | 1 | 6 | 1 | 18 | <1 | 0.02 |
| **c) Caledonia North Survey Area** | | | | | | |
| **Jul-21** | 2 | 12 | 2 | 30 | 0.71 | 0.02 |
| **Sep-21** | 4 | 23 | 6 | 41 | 0.50 | 0.04 |
| **Oct-21** | 5 | 29 | 6 | 58 | 0.45 | 0.05 |
| **Nov-21** | 7 | 41 | 7 | 82 | 0.38 | 0.07 |
| **Jan-22** | 1 | 6 | 1 | 17 | <1 | 0.01 |
| **Mar-22** | 1 | 5 | 1 | 16 | <1 | 0.01 |
| **Oct-22** | 1 | 6 | 1 | 18 | <1 | 0.01 |

**Table 43 Raw counts, unapportioned abundance and density estimates (birds per km$^2$) of large gull species in Caledonia South, Caledonia South plus 2 km buffer and Caledonia South Survey Area during the May 2021 to April 2023 survey period**

| Survey | Raw count | Total unapportioned | | | | |
|---|---|---|---|---|---|---|
| | | Abundance | LCL | UCL | Precision (CV) | Density (km$^2$) |
| **a) Caledonia South** | | | | | | |
| **Nov-21** | 7 | 40 | 7 | 86 | 0.38 | 0.19 |
| **Mar-22** | 1 | 5 | 1 | 16 | 1.00 | 0.02 |
| **Jul-22** | 8 | 47 | 8 | 128 | 0.35 | 0.22 |
| **Nov-22** | 1 | 6 | 1 | 18 | 1.00 | 0.03 |
| **Apr-23** | 1 | 6 | 1 | 17 | 1.00 | 0.03 |
| **b) Caledonia South plus 2 km buffer** | | | | | | |

| Survey | Raw count | Total unapportioned | | | | |
|---|---|---|---|---|---|---|
| | | Abundance | LCL | UCL | Precision (CV) | Density (km²) |
| **Oct-21** | 1 | 6 | 1 | 17 | 1.00 | 0.02 |
| **Nov-21** | 10 | 57 | 11 | 114 | 0.32 | 0.16 |
| **Mar-22** | 1 | 5 | 1 | 16 | 1.00 | 0.01 |
| **Jul-22** | 10 | 58 | 10 | 168 | 0.32 | 0.16 |
| **Nov-22** | 1 | 6 | 1 | 17 | 1.00 | 0.02 |
| **Apr-23** | 1 | 6 | 1 | 17 | 1.00 | 0.02 |
| **c) Caledonia South Survey Area** | | | | | | |
| **Jul-21** | 1 | 6 | 1 | 18 | 1.00 | 0.01 |
| **Oct-21** | 1 | 6 | 1 | 17 | 1.00 | 0.01 |
| **Nov-21** | 14 | 80 | 34 | 144 | 0.27 | 0.15 |
| **Mar-22** | 1 | 5 | 1 | 16 | 1.00 | 0.01 |
| **Jul-22** | 12 | 69 | 12 | 203 | 0.29 | 0.13 |
| **Nov-22** | 1 | 6 | 1 | 18 | 1.00 | 0.01 |
| **Apr-23** | 1 | 6 | 1 | 17 | 1.00 | 0.01 |

#### *ii. Distribution and behaviour*

Maps of distribution are shown in Appendix 4: Figures A4.71-80. Unidentified large gulls were recorded in the north and south of Caledonia North in July 2021 (Figure A4.71), in the southwest of Caledonia North Buffer Zone in January and October 2022 (Figures A4.75, 78). They were recorded in towards the north of Caledonia North Survey Area in September 2021 (Figure A4.72) and in the centre and west of Caledonia North Survey Area in October 2021 (Figure A4.73). In November 2021, they were loosely distributed across the Survey Area, with most individuals recorded with Caledonia South Survey Area (Figure A4.74). In March 2022, the single individuals was recorded in the north of Caledonia South near the subdivision line (Figure A4.76). In July 2022, individuals were recorded in the southwest of Caledonia South Survey Area (Figure A4.77). In November 2022 and April 2023, individuals were recorded in the south of Caledonia South near the Buffer Zone boundary (Figures A4.79, 80)

As very few birds were recorded in flight, they were too infrequent to determine any preference in flight direction (Appendix 5, Figure A5.10).

### 4.11 Unidentified gull species

#### *i. Abundance and density estimates*

A total of ten unidentified gulls were recorded in the Survey Area during both years of baseline surveys (Table 8). Unidentified gulls were recorded in very low numbers in May, July to August 2021, and in February, August and December 2022 (Table 8, Table 44). Abundance and density estimates were therefore very low (Table 44 to Table 46). Unidentified gulls have been used for apportioning to species level where possible.

**Table 44 Raw counts, unapportioned abundance and density estimates (birds per km²) of unidentified gull species in Caledonia OWF, Caledonia OWF plus 2 km buffer and the Survey Area during the May 2021 to April 2023 survey period**

| Survey | Raw count | Total unapportioned | | | | |
|---|---|---|---|---|---|---|
| | | Abundance | LCL | UCL | Precision (CV) | Density (km²) |
| **a) Caledonia OWF** | | | | | | |
| **Jul-21** | 1 | 6 | 1 | 18 | 1.00 | 0.01 |
| **Aug-22** | 1 | 6 | 1 | 17 | 1.00 | 0.01 |
| **Dec-22** | 1 | 6 | 1 | 18 | 1.00 | 0.01 |
| **b) Caledonia OWF plus 2 km buffer** | | | | | | |
| **May-21** | 1 | 6 | 1 | 17 | 1.00 | 0.01 |
| **Jul-21** | 1 | 6 | 1 | 17 | 1.00 | 0.01 |

| Survey | Raw count | Total unapportioned | | | | |
|---|---|---|---|---|---|---|
| | | Abundance | LCL | UCL | Precision (CV) | Density (km²) |
| **Feb-22** | 1 | 5 | 1 | 16 | 1.00 | 0.01 |
| **Aug-22** | 2 | 11 | 2 | 29 | 0.71 | 0.02 |
| **Dec-22** | 2 | 11 | 2 | 29 | 0.71 | 0.02 |
| **c) Survey Area** | | | | | | |
| **May-21** | 1 | 6 | 1 | 18 | 1.00 | 0.01 |
| **Jul-21** | 1 | 6 | 1 | 18 | 1.00 | 0.01 |
| **Aug-21** | 2 | 12 | 2 | 29 | 0.71 | 0.01 |
| **Feb-22** | 1 | 5 | 1 | 16 | 1.00 | 0.01 |
| **Aug-22** | 2 | 11 | 2 | 29 | 0.71 | 0.01 |
| **Dec-22** | 2 | 12 | 2 | 29 | 0.71 | 0.01 |

**Table 45 Raw counts, unapportioned abundance and density estimates (birds per km²) of unidentified gull species in Caledonia North, Caledonia North plus 2 km buffer and Caledonia North Survey Area during the May 2021 to April 2023 survey period**

| Survey | Raw count | Total unapportioned | | | | |
|---|---|---|---|---|---|---|
| | | Abundance | LCL | UCL | Precision (CV) | Density (km²) |
| **a) Caledonia North** | | | | | | |
| **Jul-21** | 1 | 6 | 1 | 18 | 1.00 | 0.03 |
| **b) Caledonia North plus 2 km buffer** | | | | | | |
| **Jul-21** | 1 | 6 | 1 | 17 | 1.00 | 0.02 |
| **Feb-22** | 1 | 5 | 1 | 16 | 1.00 | 0.01 |
| **Aug-22** | 1 | 6 | 1 | 17 | 1.00 | 0.02 |
| **Dec-22** | 1 | 6 | 1 | 18 | 1.00 | 0.02 |
| **c) Caledonia North Survey Area** | | | | | | |
| **Jul-21** | 1 | 6 | 1 | 18 | 1.00 | 0.01 |
| **Aug-21** | 2 | 12 | 2 | 29 | 0.71 | 0.02 |
| **Feb-22** | 1 | 6 | 1 | 17 | 1.00 | 0.01 |
| **Aug-22** | 1 | 6 | 1 | 17 | 1.00 | 0.01 |
| **Dec-22** | 1 | 6 | 1 | 18 | 1.00 | 0.01 |

**Table 46 Raw counts, unapportioned abundance and density estimates (birds per km²) of unidentified gull species in Caledonia South, Caledonia South plus 2 km buffer and Caledonia South Survey Area during the May 2021 to April 2023 survey period**

| Survey | Raw count | Total unapportioned | | | | |
|---|---|---|---|---|---|---|
| | | Abundance | LCL | UCL | Precision (CV) | Density (km²) |
| **a) Caledonia South** | | | | | | |
| **Aug-22** | 1 | 6 | 1 | 17 | 1.00 | 0.03 |
| **Dec-22** | 1 | 6 | 1 | 18 | 1.00 | 0.03 |
| **b) Caledonia South plus 2 km buffer** | | | | | | |
| **May-21** | 1 | 6 | 1 | 17 | 1.00 | 0.02 |
| **Aug-22** | 1 | 6 | 1 | 17 | 1.00 | 0.02 |
| **Dec-22** | 1 | 6 | 1 | 17 | 1.00 | 0.02 |
| **c) Caledonia South Survey Area** | | | | | | |
| **May-21** | 1 | 6 | 1 | 17 | 1.00 | 0.01 |
| **Aug-21** | 1 | 6 | 1 | 17 | 1.00 | 0.01 |
| **Aug-22** | 1 | 6 | 1 | 17 | 1.00 | 0.01 |
| **Dec-22** | 1 | 6 | 1 | 18 | 1.00 | 0.01 |

### *ii. Distribution and behaviour*

Maps of distribution are shown in Appendix 4: Figures A4.81-86. Overall, no apparent distributional pattern was discernible for unidentified gulls during the baseline survey period, with records scattered across the Survey Area.

As very few birds were recorded in flight, they were too infrequent to determine any preference in flight direction (Appendix 5, Figure A5.11).

## 4.12 Common tern

### *i. Abundance and density estimates*

Three common terns were recorded in the Survey Area during the first year of the baseline surveys, and none in the second year (Table 8). Common terns were recorded in the August 2021 survey only, specifically within Caledonia North (Table 47 to

Table 49). Abundance and density estimates were therefore very low (Table 47 to

Table 49). Although no common terns were definitively identified in August 2022, apportioning of ‘commic’ terns gave an abundance estimate of 6 [1; 17] in Caledonia OWF and all reporting region within Caledonia North Survey Area (Table 47 to

Table 49).

Measures of precisions were high, which was likely related to the low numbers of individuals recorded in each region (CV > 0.16; Table 47 to

Table 49).

**Table 47 Raw counts, unapportioned and apportioned abundance and density estimates (birds per km$^2$) of common terns in Caledonia OWF, Caledonia OWF plus 2 km buffer and the Survey Area during the May 2021 to April 2023 survey period**

| Survey | Raw count | Total unapportioned | | | | | Total apportioned | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Abundance | LCL | UCL | Precision (CV) | Density (km$^2$) | Abundance | LCL | UCL | Density (km$^2$) |
| **a) Caledonia OWF** | | | | | | | | | | |
| **Aug-21** | 3 | 17 | 3 | 52 | 0.58 | 0.04 | 29 | 5 | 87 | 0.07 |
| **Aug-22** | 0 | - | - | - | - | - | 6 | 1 | 17 | 0.01 |
| **b) Caledonia OWF plus 2 km buffer** | | | | | | | | | | |
| **Aug-21** | 3 | 17 | 3 | 51 | 0.58 | 0.03 | 28 | 5 | 85 | 0.04 |
| **c) Survey Area** | | | | | | | | | | |
| **Aug-21** | 3 | 17 | 3 | 52 | 0.58 | 0.02 | 29 | 5 | 87 | 0.03 |

**Table 48 Raw counts, unapportioned and apportioned abundance and density estimates (birds per km$^2$) of common terns in Caledonia North, Caledonia North plus 2 km buffer and Caledonia North Survey Area during the May 2021 to April 2023 survey period**

| Survey | Raw count | Total unapportioned | | | | | Total apportioned | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Abundance | LCL | UCL | Precision (CV) | Density (km$^2$) | Abundance | LCL | UCL | Density (km$^2$) |
| **a) Caledonia North** | | | | | | | | | | |
| **Aug-21** | 3 | 17 | 3 | 52 | 0.58 | 0.08 | 29 | 5 | 87 | 0.13 |
| **Aug-22** | - | - | - | - | - | - | 6 | 1 | 17 | 0.03 |
| **b) Caledonia North plus 2 km buffer** | | | | | | | | | | |
| **Aug-21** | 3 | 17 | 3 | 51 | 0.58 | 0.05 | 28 | 5 | 85 | 0.07 |
| **Aug-22** | - | - | - | - | - | - | 6 | 1 | 17 | 0.02 |
| **c) Caledonia North Survey Area** | | | | | | | | | | |
| **Aug-21** | 3 | 17 | 3 | 52 | 0.58 | 0.03 | 29 | 5 | 87 | 0.03 |
| **Aug-22** | - | - | - | - | - | - | 6 | 1 | 17 | 0.03 |

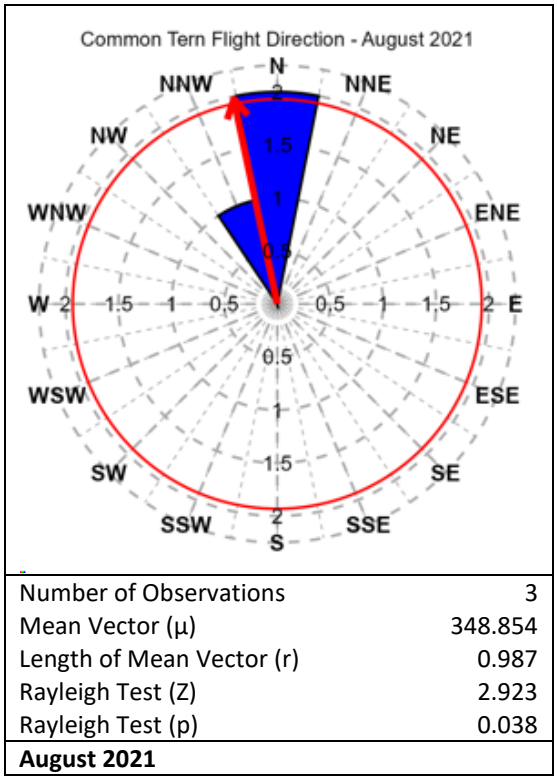
**Table 49** **Raw counts, unapportioned and apportioned abundance and density estimates (birds per km$^2$) of common terns in Caledonia South, Caledonia South plus 2 km and Caledonia South Survey Area during the May 2021 to April 2023 survey period**

| Survey | Raw count | Total unapportioned | | | | | Total apportioned | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Abundance | LCL | UCL | Precision (CV) | Density (km$^2$) | Abundance | LCL | UCL | Density (km$^2$) |
| **a) Caledonia South** | | | | | | | | | | |
| None recorded | | | | | | | | | | |
| **b) Caledonia South plus 2 km buffer** | | | | | | | | | | |
| None recorded | | | | | | | | | | |
| **c) Caledonia South Survey Area** | | | | | | | | | | |
| **Aug-21** | 3 | 17 | 3 | 52 | 0.58 | 0.03 | 29 | 5 | 87 | 0.05 |

### *ii. Distribution and behaviour*

All common terns were recorded in the southwest of Caledonia North towards the boundary with the Buffer Zone (Appendix 4, Figure A4.87).

All common terns were recorded in flight, with a significant predominant direction of north-northwest (Figure 14).




| | |
|---|---|
| Number of Observations | 3 |
| Mean Vector (μ) | 348.854 |
| Length of Mean Vector (r) | 0.987 |
| Rayleigh Test (Z) | 2.923 |
| Rayleigh Test (p) | 0.038 |
| **August 2021** | |

**Figure 14** **Summary of flight direction of common terns within surveys where a significant flight direction was recorded during the May 2021 to April 2023 survey period**

### 4.13 Arctic tern

#### *i. Abundance and density estimates*

A total of 15 Arctic terns were recorded in the Survey Area during the baseline surveys, three individuals in Caledonia North Survey Area and 12 individuals in Caledonia South Survey Area (Table 8 to Table 10). All records were made within the breeding season for this species (May to August), though the low numbers of birds recorded indicates that the Survey Area is of limited importance to this species. Arctic terns were recorded only in the 2 km and 4 km Buffer Zones, with none recorded in Caledonia OWF, and subsequently in Caledonia North and Caledonia South (Table 50 to Table 52). Despite this, some apportioned unidentified terns ('commic' tern and / or tern species) within Caledonia OWF mean that low abundances of Arctic tern were reported in Caledonia OWF during the May 2022 survey. Peak numbers of Arctic terns were recorded in May 2021 in the Survey Area, with 9 individuals, resulting in an unapportioned mean abundance estimate of 53 [12; 117] and an apportioned mean abundance estimate of 77 [16;188] individuals (Table 50). These equated to mean density estimates of 0.06 (unapportioned) and 0.09 (apportioned) birds/km$^2$ (Table 50).

Measures of precisions were high, which was likely related to the low numbers of individuals recorded in each region (CV > 0.16; Table 50).

**Table 50 Raw counts, unapportioned and apportioned abundance and density estimates (birds per km$^2$) of Arctic terns in Caledonia OWF, Caledonia OWF plus 2 km buffer and the Survey Area during the May 2021 to April 2023 survey period**

| Survey | Raw count | Total unapportioned | | | | | Total apportioned | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Abundance | LCL | UCL | Precision (CV) | Density (km$^2$) | Abundance | LCL | UCL | Density (km$^2$) |
| **a) Caledonia OWF** | | | | | | | | | | |
| **May-22** | 0 | - | - | - | - | - | 12 | 2 | 35 | 0.03 |
| **b) Caledonia OWF plus 2 km buffer** | | | | | | | | | | |
| **May-21** | 7 | 40 | 7 | 98 | 0.38 | 0.06 | 69 | 11 | 172 | 0.11 |
| **May-22** | 0 | - | - | - | - | - | 11 | 2 | 34 | 0.02 |
| **Aug-22** | 5 | 29 | 5 | 69 | 0.45 | 0.05 | 58 | 10 | 138 | 0.09 |
| **c) Survey Area** | | | | | | | | | | |
| **May-21** | 9 | 53 | 12 | 117 | 0.33 | 0.06 | 77 | 16 | 188 | 0.09 |
| **May-22** | 0 | - | - | - | - | - | 12 | 2 | 35 | 0.01 |
| **Aug-22** | 6 | 34 | 6 | 75 | 0.41 | 0.04 | 80 | 17 | 167 | 0.09 |

A peak of three individuals was recorded in Caledonia North Survey Area (Table 51). This resulted in an unapportioned and apportioned mean abundance estimate of 18 [3; 41-47] individuals, which equated to a mean density estimate of 0.03 birds/km$^2$ (Table 51).

Measures of precisions were high, which was likely related to the low numbers of individuals recorded in each region (CV > 0.16; Table 51).

**Table 51 Raw counts, unapportioned and apportioned abundance and density estimates (birds per km$^2$) of Arctic terns in Caledonia North, Caledonia North plus 2 km buffer and Caledonia North Survey Area during the May 2021 to April 2023 survey period**

| Survey | Raw count | Total unapportioned | | | | | Total apportioned | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Abundance | LCL | UCL | Precision (CV) | Density (km$^2$) | Abundance | LCL | UCL | Density (km$^2$) |
| **a) Caledonia North** | | | | | | | | | | |
| **May-22** | - | - | - | - | - | - | 12 | 2 | 35 | 0.05 |
| **b) Caledonia North plus 2 km buffer** | | | | | | | | | | |
| **May-21** | 1 | 6 | 1 | 17 | 1.00 | 0.02 | 6 | 1 | 17 | 0.02 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **May-22** | - | - | - | - | - | - | 11 | 2 | 34 | 0.03 |
| **c) Caledonia North Survey Area** | | | | | | | | | | |
| **May-21** | 3 | 18 | 3 | 47 | 0.58 | 0.03 | 18 | 3 | 41 | 0.03 |
| **May-22** | - | - | - | - | - | - | 12 | 2 | 35 | 0.02 |

In Caledonia South Survey Area, six individuals were recorded in May 2021 and August 2022. In May 2021, this resulted in an unapportioned mean abundance estimate of 35 [6; 99] and apportioned mean abundance estimate of 58 [10; 162] individuals (Table 52). These equated to mean density estimates of 0.07 (unapportioned) and 0.11 (apportioned) birds/km$^2$ (Table 52). In August 2022, the six individuals resulted in an unapportioned mean abundance estimate of 34 [6; 75] and apportioned mean abundance estimate of 74 [13; 155] individuals (Table 52). These equated to mean density estimates of 0.06 (unapportioned) and 0.14 (apportioned) birds/km$^2$ (Table 52).

Measures of precisions were high, which was likely related to the low numbers of individuals recorded in each region (CV > 0.16; Table 52).

**Table 52 Raw counts, unapportioned and apportioned abundance and density estimates (birds per km$^2$) of Arctic terns in Caledonia South, Caledonia South plus 2 km buffer and Caledonia South Survey Area during the May 2021 to April 2023 survey period**

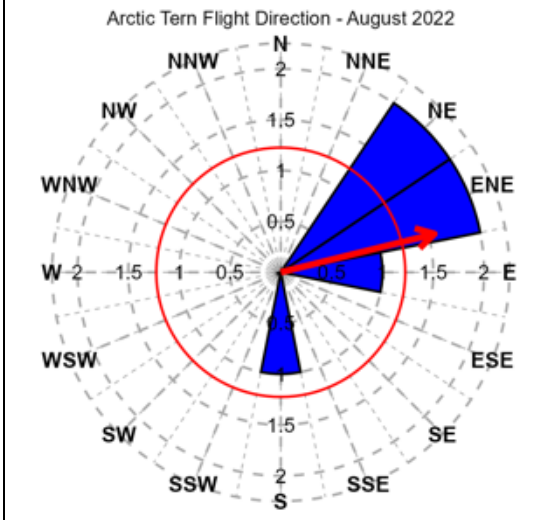
| Survey | Raw count | Total unapportioned | | | | | Total apportioned | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Abundance | LCL | UCL | Precision (CV) | Density (km$^2$) | Abundance | LCL | UCL | Density (km$^2$) |
| **a) Caledonia South** | | | | | | | | | | |
| None recorded | | | | | | | | | | |
| **b) Caledonia South plus 2 km buffer** | | | | | | | | | | |
| **May-21** | 6 | 35 | 6 | 98 | 0.41 | 0.10 | 58 | 29 | 161 | 0.16 |
| **Aug-22** | 5 | 29 | 5 | 69 | 0.45 | 0.08 | 52 | 28 | 126 | 0.14 |
| **c) Caledonia South Survey Area** | | | | | | | | | | |
| **May-21** | 6 | 35 | 6 | 99 | 0.41 | 0.07 | 58 | 10 | 162 | 0.11 |
| **Aug-22** | 6 | 34 | 6 | 75 | 0.41 | 0.06 | 74 | 13 | 155 | 0.14 |

### *ii. Distribution and behaviour*

Arctic terns were recorded within the Survey Area Buffer Zone both in May 2021 and August 2022; they were recorded in the northeast and south of the Survey Area Buffer Zone in May whereas they were only in Caledonia South Buffer Zone in August, specifically in the east and south of the Buffer Zone (Appendix 4, Figure A4.88-89).

In August 2022, Arctic terns were recorded flying in a significant east-northeasterly direction (Figure 15).

As very few birds were recorded in flight in other surveys, they were too infrequent to determine any preference in flight direction (Appendix 5, Figure A5.12).




| | |
|---|---|
| Number of Observations | 6 |
| Mean Vector (μ) | 76.705 |
| Length of Mean Vector (r) | 0.778 |
| Rayleigh Test (Z) | 3.636 |
| Rayleigh Test (p) | 0.019 |
| **August 2022** | |

**Figure 15 Summary of flight direction of Arctic terns within surveys where a significant flight direction was recorded during the May 2021 to April 2023 survey period**

## 4.14 'Commic' tern

### *i. Abundance and density estimates*

A total of 19 'commic' terns were recorded in the Survey Area during both years of baseline surveys (Table 8). 'Commic' terns were recorded in low numbers in May 2021, August 2021 and August 2022 (Table 53). In the Survey Area, a peak of eight individuals were recorded in August 2022, resulting in an unapportioned mean abundance estimate of 46 [11; 92] individuals (Table 53). This equated to a mean density estimate of 0.05 birds/km$^2$ (Table 53). 'Commic' terns have been used for apportioning to species level where possible.

**Table 53 Raw counts, unapportioned abundance and density estimates (birds per km$^2$) of 'commic' terns in Caledonia OWF, Caledonia OWF plus 2 km buffer and the Survey Area during the May 2021 to April 2023 survey period**

| Survey | Raw count | Total unapportioned | | | | |
|---|---|---|---|---|---|---|
| | | Abundance | LCL | UCL | Precision (CV) | Density (km$^2$) |
| **a) Caledonia OWF** | | | | | | |
| **Aug-21** | 2 | 12 | 2 | 35 | 0.58 | 0.03 |
| **May-22** | 4 | 23 | 4 | 70 | 0.71 | 0.05 |
| **Aug-22** | 1 | 6 | 1 | 17 | 0.50 | 0.01 |
| **b) Caledonia OWF plus 2 km buffer** | | | | | | |
| **May-21** | 3 | 17 | 3 | 52 | 0.58 | 0.03 |
| **Aug-21** | 2 | 11 | 2 | 34 | 0.71 | 0.02 |
| **May-22** | 4 | 23 | 4 | 69 | 0.50 | 0.04 |
| **Aug-22** | 5 | 29 | 5 | 74 | 0.45 | 0.05 |
| **c) Survey Area** | | | | | | |
| **May-21** | 3 | 18 | 3 | 53 | 0.58 | 0.02 |
| **Aug-21** | 2 | 12 | 2 | 35 | 0.71 | 0.01 |
| **May-22** | 6 | 35 | 6 | 93 | 0.41 | 0.04 |

| Survey | Raw count | Total unapportioned | | | | |
|---|---|---|---|---|---|---|
| | | Abundance | LCL | UCL | Precision (CV) | Density (km²) |
| **Aug-22** | 8 | 46 | 11 | 92 | 0.35 | 0.05 |

In Caledonia North Survey Area, the peak number of 'commic' terns recorded was six individuals in May 2022, resulting in an unapportioned mean abundance estimate of 35 [6; 81] individuals (Table 54). This equated to a mean density estimate of 0.06 birds/km$^2$ (Table 54).

**Table 54 Raw counts, unapportioned abundance and density estimates (birds per km$^2$) of 'commic' terns in Caledonia North, Caledonia North plus 2 km buffer and Caledonia North Survey Area during the May 2021 to April 2023 survey period**

| Survey | Raw count | Total unapportioned | | | | |
|---|---|---|---|---|---|---|
| | | Abundance | LCL | UCL | Precision (CV) | Density (km²) |
| **a) Caledonia North** | | | | | | |
| **Aug-21** | 2 | 12 | 2 | 35 | 0.71 | 0.05 |
| **May-22** | 4 | 23 | 4 | 70 | 0.50 | 0.11 |
| **Aug-22** | 1 | 6 | 1 | 17 | <1 | 0.03 |
| **b) Caledonia North plus 2 km buffer** | | | | | | |
| **Aug-21** | 2 | 11 | 2 | 34 | 0.71 | 0.03 |
| **May-22** | 4 | 23 | 4 | 68 | 0.50 | 0.06 |
| **Aug-22** | 1 | 6 | 1 | 17 | <1 | 0.02 |
| **c) Caledonia North Survey Area** | | | | | | |
| **Aug-21** | 2 | 12 | 2 | 35 | 0.71 | 0.02 |
| **May-22** | 6 | 35 | 6 | 81 | 0.41 | 0.06 |
| **Aug-22** | 1 | 6 | 1 | 17 | <1 | 0.01 |

In Caledonia South Survey Area, a peak count of seven individuals was recorded in August 2022, resulting in an unapportioned mean abundance estimate of 40 [7; 86] individuals (Table 55). This equated to a mean density estimate of 0.07 birds/km$^2$ (Table 55).

**Table 55 Raw counts, unapportioned abundance and density estimates (birds per km$^2$) of 'commic' terns in Caledonia South, Caledonia South plus 2 km buffer and Caledonia South Survey Area during the May 2021 to April 2023 survey period**

| Survey | Raw count | Total unapportioned | | | | |
|---|---|---|---|---|---|---|
| | | Abundance | LCL | UCL | Precision (CV) | Density (km²) |
| **a) Caledonia South** | | | | | | |
| None recorded | | | | | | |
| **b) Caledonia South plus 2 km buffer** | | | | | | |
| **May-21** | 3 | 17 | 3 | 52 | 0.58 | 0.05 |
| **Aug-22** | 4 | 23 | 4 | 57 | 0.50 | 0.06 |
| **c) Caledonia South Survey Area** | | | | | | |
| **May-21** | 3 | 17 | 3 | 52 | 0.58 | 0.03 |
| **Aug-21** | 2 | 12 | 2 | 35 | 0.71 | 0.02 |
| **May-22** | 2 | 11 | 2 | 34 | 0.71 | 0.02 |
| **Aug-22** | 7 | 40 | 7 | 86 | 0.38 | 0.07 |

### *ii. Distribution and behaviour*

Maps of 'commic' tern distribution are shown in Appendix 4: Figures A4.90-93. In May 2021, they were recorded in the south of Caledonia South Buffer Zone near Caledonia South boundary (Figure A4.90). In August 2021, they were recorded in the southwest of Caledonia North, close to the Buffer Zone boundary (Figure A4.91). In May 2022, they were recorded in the north of the Caledonia North and in the southeast of Caledonia North Buffer Zone (Figure A4.92). In August 2022, individuals were recorded in the north of Caledonia North and in the east, south and southwest of Caldonia South Buffer Zone (Figure A4.93).

As very few birds were recorded in flight, they were too infrequent to determine any preference in flight direction (Appendix 5, Figure A5.13).

### 4.15 Unidentified tern species

#### *i. Abundance and density estimates*

Three unidentified terns were recorded in the Survey Area during the first year of the baseline surveys, none were recorded during the second year of surveys (Table 8), or in Caledonia OWF during either year (Table 56). Unidentified tern species were recorded in low numbers in the May and July 2021 surveys (Table 56). In the Survey Area, a peak of two individuals was recorded in July 2021, resulting in an unapportioned mean abundance estimate of 12 [2; 36] individuals, which equated to a mean density estimate of 0.01 birds/km$^2$ (Table 56). Unidentified tern species have been used for apportioning to species level where possible.

**Table 56 Raw counts, unapportioned abundance and density estimates (birds per km$^2$) of unidentified tern species in Caledonia OWF, Caledonia OWF plus 2 km buffer and the Survey Area during the May 2021 to April 2023 survey period**

| Survey | Raw count | Total unapportioned | | | | |
|---|---|---|---|---|---|---|
| | | Abundance | LCL | UCL | Precision (CV) | Density (km$^2$) |
| **a) Caledonia OWF** | | | | | | |
| None recorded | | | | | | |
| **b) Caledonia OWF plus 2 km buffer** | | | | | | |
| **May-21** | 1 | 6 | 1 | 17 | 1.00 | 0.01 |
| **Jul-21** | 2 | 12 | 2 | 35 | 0.71 | 0.02 |
| **c) Survey Area** | | | | | | |
| **May-21** | 1 | 6 | 1 | 18 | 1.00 | 0.01 |
| **Jul-21** | 2 | 12 | 2 | 36 | 0.71 | 0.01 |

In Caledonia North Survey Area, two individuals were recorded in the 2 km Buffer Zone in July 2021, resulting in an unapportioned mean abundance estimate of 12 [2; 36] individuals in the Caledonia North Survey Area (Table 57). This equated to a mean density estimate of 0.02 birds/km$^2$ (Table 57).

**Table 57 Raw counts, unapportioned abundance and density estimates (birds per km$^2$) of unidentified tern species in Caledonia North, Caledonia North plus 2 km buffer and Caledonia North Survey Area during the May 2021 to April 2023 survey period**

| Survey | Raw count | Total unapportioned | | | | |
|---|---|---|---|---|---|---|
| | | Abundance | LCL | UCL | Precision (CV) | Density (km$^2$) |
| **a) Caledonia North** | | | | | | |
| None recorded | | | | | | |
| **b) Caledonia North plus 2 km buffer** | | | | | | |
| **Jul-21** | 2 | 12 | 2 | 35 | 0.71 | 0.03 |
| **c) Caledonia North Survey Area** | | | | | | |
| **Jul-21** | 2 | 12 | 2 | 36 | 0.71 | 0.02 |

A single individual was recorded in the 2 km Buffer Zone in May 2021 (Table 58). This resulted in an unapportioned mean abundance estimate of 6 [1; 17] individuals in the Caledonia South Survey Area (Table 58). This equated to a mean density estimate of 0.01 birds/km$^2$ (Table 58).

**Table 58 Raw counts, unapportioned abundance and density estimates (birds per km$^2$) of unidentified tern species in Caledonia South, Caledonia South plus 2 km buffer and Caledonia South Survey Area during the May 2021 to April 2023 survey period**

| Survey | Raw count | Total unapportioned | | | | |
|---|---|---|---|---|---|---|
| | | Abundance | LCL | UCL | Precision (CV) | Density (km$^2$) |
| **a) Caledonia South** | | | | | | |

| Survey | Raw count | Total unapportioned | | | | |
|---|---|---|---|---|---|---|
| | | Abundance | LCL | UCL | Precision (CV) | Density (km²) |
| None recorded | | | | | | |
| **b) Caledonia South plus 2 km buffer** | | | | | | |
| **May-21** | 1 | 6 | 1 | 17 | 1.00 | 0.02 |
| **c) Caledonia South Survey Area** | | | | | | |
| **May-21** | 1 | 6 | 1 | 17 | 1.00 | 0.01 |

#### *ii. Distribution and behaviour*

Unidentified terns were recorded in south of the Survey Area, in Caledonia South Buffer Zone near the boundary with Caledonia South in May 2021 (Appendix 4, Figure A4.94) whereas they were they were recorded in northeast of Caledonia North Buffer Zone, near the boundary with Caledonia North in July 2021 (Appendix 4, Figure A4.95).

As only one bird was recorded in flight, they were too infrequent to determine any preference in flight direction (Appendix 5, Figure A5.14).

### 4.16 Great skua

#### *i. Abundance and density estimates*

##### *Caledonia OWF*

A total of 22 great skuas were recorded in the Survey Area during both years of baseline surveys (Table 8). Only two great skuas were recorded during the second year of surveys (Table 8). All records of great skuas were made during the breeding season (mid-April to mid-September) (

Table 59, Figure 16). Peak numbers were recorded in July 2021 (

Table 59, Figure 16):

- Four individuals were recorded in Caledonia OWF, resulting in an unapportioned and apportioned mean abundance estimates of 24 [4; 65-71] individuals. Both equated to a mean density estimate of 0.06 birds/km$^2$.
- Six birds were recorded in Caledonia OWF plus 2 km buffer, resulting in an unapportioned and apportioned mean abundance estimate of 35 [6; 93-99] individuals. Both equated to a mean density estimate of 0.05 birds/km$^2$.
- Ten individuals were recorded in the Survey Area, resulting in an unapportioned and apportioned mean abundance estimates of 60 [4; 65-71] individuals. Both equated to a mean density estimate of 0.07 birds/km$^2$.

Whilst present within the Survey Area during both breeding seasons, the trends observed for great skua abundance in this seasonal period were characterised by relatively consistent and low apportioned mean abundances across all reporting regions. Birds were recorded much more frequently in the 2021 breeding season than in the 2022 breeding season.

Great skuas were not recorded during the non-breeding season (mid-September to mid-April) (

Table 59, Figure 16).

Measures of precision were high in all surveys in which this species was recorded, which is likely related to the low numbers of individuals recorded in each region (CV > 0.16;

Table 59).

**Table 59** **Raw counts, unapportioned and apportioned abundance and density estimates (birds per km$^2$) of great skuas in Caledonia OWF, Caledonia OWF plus 2 km buffer and the Survey Area during the May 2021 to April 2023 survey period. A colour gradient, light yellow to orange (peak number), follow the ascending order of great skua raw counts breeding season months (mid-April to mid-September)**

| Survey | Raw count | Total unapportioned | | | | | Total apportioned | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Abundance | LCL | UCL | Precision (CV) | Density (km$^2$) | Abundance | LCL | UCL | Density (km$^2$) |
| **a) Caledonia OWF** | | | | | | | | | | |
| **May-21** | 1 | 6 | 1 | 17 | 1.00 | 0.01 | 6 | 1 | 17 | 0.01 |
| **Jun-21** | 2 | 12 | 2 | 29 | 0.71 | 0.03 | 12 | 2 | 36 | 0.03 |
| **Jul-21** | **4** | **24** | **4** | **65** | **0.50** | **0.06** | **24** | **4** | **71** | **0.06** |
| **Aug-21** | **4** | **23** | **4** | **64** | **0.50** | **0.05** | **23** | **4** | **58** | **0.05** |
| **Jul-22** | 2 | 12 | 2 | 35 | 0.71 | 0.03 | 12 | 2 | 36 | 0.03 |
| **b) Caledonia OWF plus 2 km buffer** | | | | | | | | | | |
| **May-21** | 1 | 6 | 1 | 17 | 1.00 | 0.01 | 6 | 1 | 17 | 0.01 |
| **Jun-21** | 2 | 12 | 2 | 29 | 0.71 | 0.02 | 12 | 2 | 34 | 0.02 |
| **Jul-21** | **6** | **35** | **6** | **93** | **0.41** | **0.05** | **35** | **6** | **99** | **0.05** |
| **Aug-21** | 5 | 29 | 5 | 68 | 0.45 | 0.05 | 29 | 5 | 68 | 0.05 |
| **Jul-22** | 2 | 12 | 2 | 35 | 0.71 | 0.02 | 12 | 2 | 34 | 0.02 |
| **c) Survey Area** | | | | | | | | | | |
| **May-21** | 1 | 6 | 1 | 18 | 1.00 | 0.01 | 6 | 1 | 18 | 0.01 |
| **Jun-21** | 2 | 12 | 2 | 29 | 0.71 | 0.01 | 12 | 2 | 36 | 0.01 |
| **Jul-21** | **10** | **60** | **10** | **133** | **0.32** | **0.07** | **60** | **12** | **145** | **0.07** |
| **Aug-21** | 6 | 35 | 6 | 81 | 0.41 | 0.04 | 35 | 6 | 75 | 0.04 |
| **Sep-21** | 1 | 6 | 1 | 18 | 1.00 | 0.01 | 6 | 1 | 18 | 0.01 |
| **Jul-22** | 2 | 12 | 2 | 35 | 0.71 | 0.01 | 12 | 2 | 36 | 0.01 |

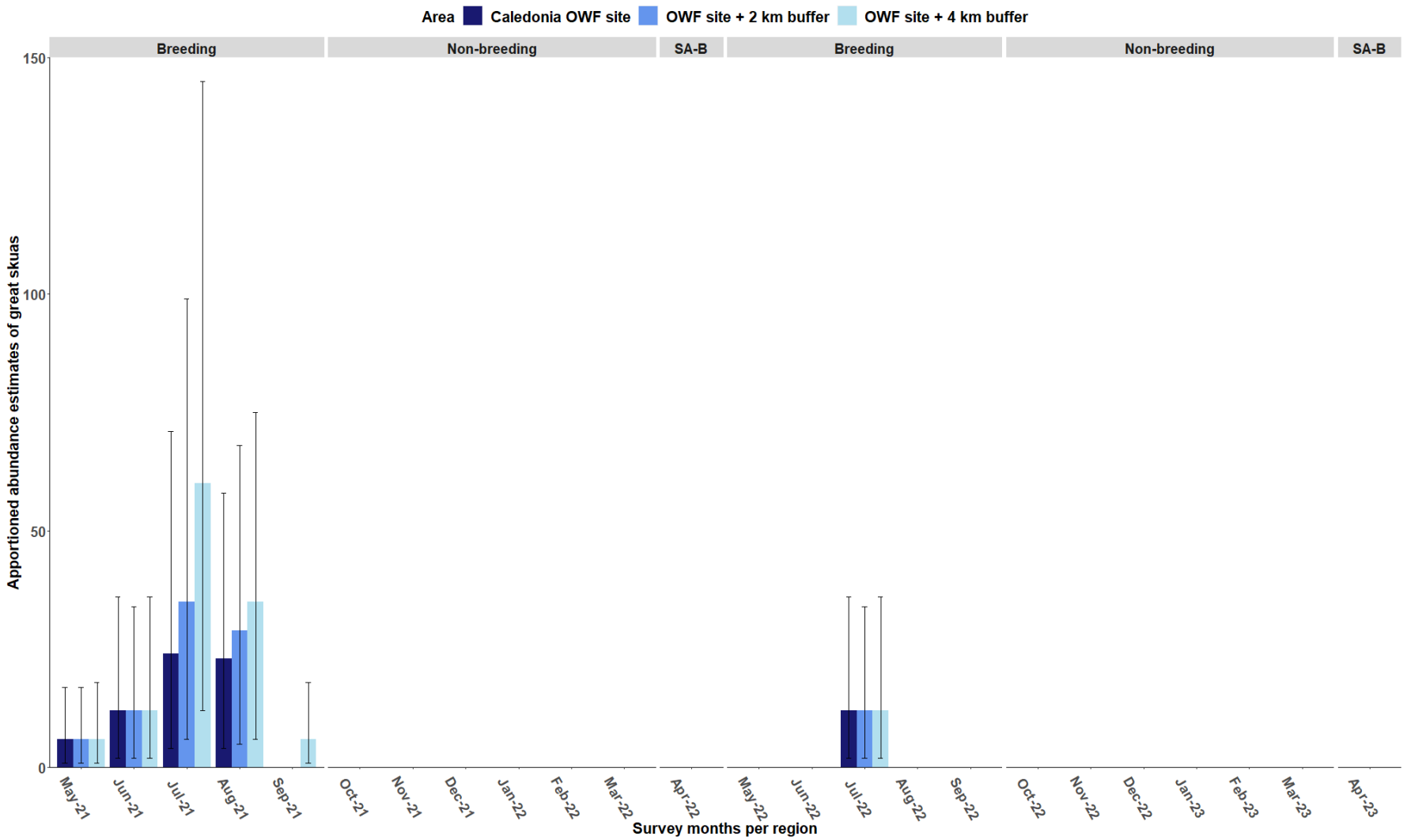



**Figure 16 Bar plot of the monthly apportioned abundances estimates (with 95% confidence intervals) of total great skuas recorded in each reporting region of the Survey Area, during the May 2021 to April 2023 survey period. Great skua seasonal periods are also displayed. SA-B corresponds to month split between breeding site attendance (SA) and breeding (B)**

### *Caledonia North*

A total of 16 great skuas were recorded in Caledonia North Survey Area during both years of baseline surveys, with only two of these being recorded during the second year of surveys (Table 9). The peak count was recorded in August 2021 (Table 60, Figure 17):

- Three individuals were recorded in Caledonia North, resulting in an unapportioned and apportioned mean abundance estimate of 17 [3; 41] individuals. Both equated to a mean density estimate of 0.08 birds/km$^2$.
- Four individuals were recorded in Caledonia North plus 2 km, resulting in an unapportioned and apportioned mean abundance estimate of 23 [4; 57] individuals. Both equated to a mean density estimate of 0.06 birds/km$^2$.
- Six individuals were recorded in Caledonia North Survey Area, resulting in an unapportioned and apportioned mean abundance estimate of 35 [6; 75] individuals. Both equated to a mean density estimate of 0.06 birds/km$^2$.

Whilst present within Caledonia North Survey Area during both breeding seasons, the trends observed for great skua abundance in this seasonal period were characterised by relatively consistent and low apportioned mean abundances across all reporting regions. Great skuas were recorded much more frequently in the 2021 breeding season than in the 2022 breeding season.

Great skuas were absent during the non-breeding season (mid-September to mid-April) (Table 60, Figure 17).

Measures of precisions were high, which is likely related to the low numbers of individuals recorded in each region (CV > 0.16; Table 60).

**Table 60 Raw counts, unapportioned and apportioned abundance and density estimates (birds per km$^2$) of great skuas in Caledonia North, Caledonia North plus 2 km buffer and Caledonia North Survey Area during the May 2021 to April 2023 survey period. A colour gradient, light yellow to orange (peak number), follow the ascending order of great skua raw counts breeding season months (mid-April to mid-September)**

| Survey | Raw count | Total unapportioned | | | | | Total apportioned | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Abundance | LCL | UCL | Precision (CV) | Density (km$^2$) | Abundance | LCL | UCL | Density (km$^2$) |
| **a) Caledonia North** | | | | | | | | | | |
| **May-21** | 1 | 6 | 1 | 17 | 1.00 | 0.03 | 6 | 1 | 17 | 0.03 |
| **Jun-21** | 2 | 12 | 2 | 30 | 0.71 | 0.05 | 12 | 2 | 36 | 0.05 |
| **Jul-21** | 1 | 6 | 1 | 18 | 1.00 | 0.03 | 6 | 1 | 18 | 0.03 |
| **Aug-21** | **3** | **17** | **3** | **41** | **0.58** | **0.08** | **17** | **3** | **41** | **0.08** |
| **Jul-22** | 1 | 6 | 1 | 18 | 1.00 | 0.03 | 6 | 1 | 18 | 0.03 |
| **b) Caledonia North plus 2 km buffer** | | | | | | | | | | |
| **May-21** | 1 | 6 | 1 | 17 | 1.00 | 0.02 | 6 | 1 | 17 | 0.02 |
| **Jun-21** | 2 | 12 | 2 | 29 | 0.71 | 0.03 | 12 | 2 | 34 | 0.03 |
| **Jul-21** | 1 | 6 | 1 | 17 | 1.00 | 0.02 | 6 | 1 | 17 | 0.02 |
| **Aug-21** | **4** | **23** | **4** | **57** | **0.50** | **0.06** | **23** | **4** | **57** | **0.06** |
| **Jul-22** | 1 | 6 | 1 | 17 | 1.00 | 0.02 | 6 | 1 | 17 | 0.02 |
| **c) Caledonia North Survey Area** | | | | | | | | | | |
| **May-21** | 1 | 6 | 1 | 18 | 1.00 | 0.01 | 6 | 1 | 18 | 0.01 |
| **Jun-21** | 2 | 12 | 2 | 30 | 0.71 | 0.02 | 12 | 2 | 36 | 0.02 |
| **Jul-21** | 5 | 30 | 5 | 73 | 0.45 | 0.05 | 30 | 5 | 72 | 0.05 |
| **Aug-21** | **6** | **35** | **6** | **75** | **0.41** | **0.06** | **35** | **6** | **75** | **0.06** |
| **Jul-22** | 2 | 12 | 2 | 35 | 0.71 | 0.02 | 12 | 2 | 36 | 0.02 |

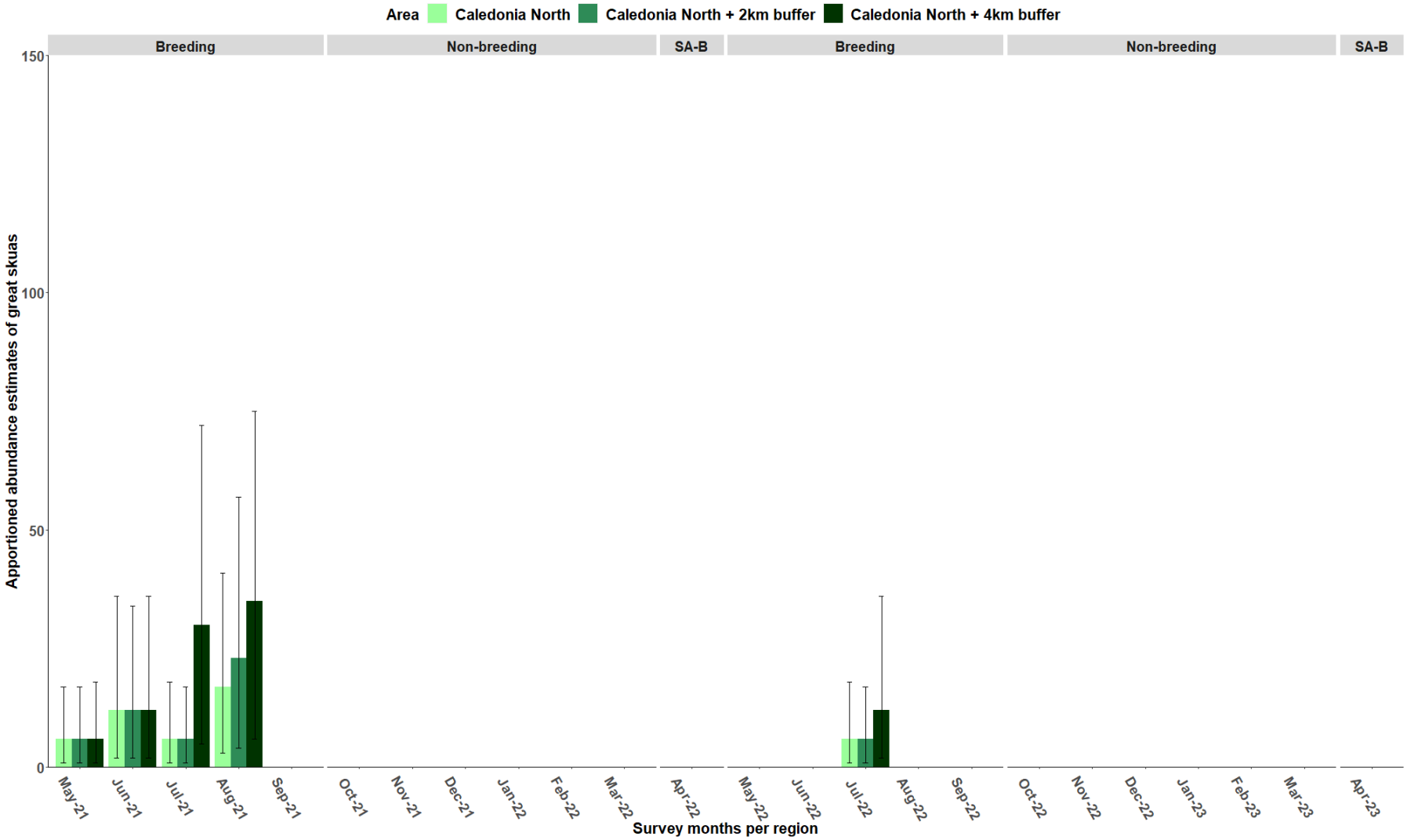



**Figure 17 Bar plot of the monthly apportioned abundances estimates (with 95% confidence intervals) of total great skuas recorded in each reporting region of Caledonia North Survey Area, during the May 2021 to April 2023 survey period. Great skua seasonal periods are also displayed. SA-B corresponds to month split between breeding site attendance (SA) and breeding (B)**

### *Caledonia South*

A total of 11 great skuas were recorded in Caledonia South Survey Area during both years of baseline surveys, with a single individual recorded in 2022 (Figure 10). All records of great skuas were made, in low numbers, during the breeding season (between mid-April to mid-September) (Table 61, Figure 18). Peak numbers were recorded in July 2021 (Table 61, Figure 18):

- Three individuals were recorded in Caledonia South, resulting in an unapportioned and apportioned mean abundance estimate of 18 [3; 53] individuals. Both equated to a mean density estimate of 0.09 birds/km$^2$.
- Five individuals were recorded in Caledonia South plus 2 km, resulting in an unapportioned and apportioned mean abundance estimate of 30 [5; 90] individuals. Both equated to a mean density estimate of 0.08 birds/km$^2$.
- Five individuals were recorded in Caledonia South Survey Area, resulting in an unapportioned and apportioned mean abundance estimate of 30 [5; 90] individuals. Both equated to a mean density estimate of 0.06 birds/km$^2$.

Whilst present within Caledonia South Survey Area during both breeding seasons, the trends observed for great skua abundance in this seasonal period were characterised by relatively consistent and low apportioned mean abundances across all reporting regions. Great skuas were recorded much more frequently in the 2021 breeding season than in the 2022 breeding season.

Great skuas were recorded absent during the non-breeding season (mid-September to mid-April) (Table 61, Figure 18).

Measures of precisions were high, which was likely related to the low numbers of individuals recorded in each region (CV > 0.16; Table 61).

**Table 61 Raw counts, unapportioned and apportioned abundance and density estimates (birds per km$^2$) of great skuas in Caledonia South, Caledonia South plus 2 km buffer and Caledonia South Survey Area during the May 2021 to April 2023 survey period. A colour gradient, light yellow to orange (peak number), follow the ascending order of great skua raw counts breeding season months (mid-April to mid-September)**

| Survey | Raw count | Total unapportioned | | | | | Total apportioned | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Abundance | LCL | UCL | Precision (CV) | Density (km$^2$) | Abundance | LCL | UCL | Density (km$^2$) |
| **a) Caledonia South** | | | | | | | | | | |
| **Jul-21** | **3** | **18** | **3** | **53** | **0.58** | **0.09** | **18** | **3** | **53** | **0.09** |
| **Aug-21** | 1 | 6 | 1 | 17 | 1.00 | 0.03 | 6 | 1 | 17 | 0.03 |
| **Jul-22** | 1 | 6 | 1 | 17 | 1.00 | 0.03 | 6 | 1 | 17 | 0.03 |
| **b) Caledonia South plus 2 km buffer** | | | | | | | | | | |
| **Jun-21** | 1 | 6 | 1 | 17 | 1.00 | 0.02 | 6 | 1 | 17 | 0.02 |
| **Jul-21** | **5** | **29** | **5** | **87** | **0.45** | **0.08** | **29** | **5** | **87** | **0.08** |
| **Aug-21** | 2 | 11 | 2 | 29 | 0.71 | 0.03 | 11 | 2 | 29 | 0.03 |
| **Jul-22** | 1 | 6 | 1 | 17 | 1.00 | 0.02 | 6 | 1 | 17 | 0.02 |
| **c) Caledonia South Survey Area** | | | | | | | | | | |
| **Jun-21** | 2 | 12 | 2 | 29 | 0.71 | 0.02 | 12 | 2 | 34 | 0.02 |
| **Jul-21** | **5** | **30** | **5** | **90** | **0.45** | **0.06** | **30** | **5** | **90** | **0.06** |
| **Aug-21** | 2 | 12 | 2 | 29 | 0.71 | 0.02 | 12 | 2 | 29 | 0.02 |
| **Sep-21** | 1 | 6 | 1 | 17 | 1.00 | 0.01 | 6 | 1 | 17 | 0.01 |
| **Jul-22** | 1 | 6 | 1 | 17 | 1.00 | 0.01 | 6 | 1 | 17 | 0.01 |

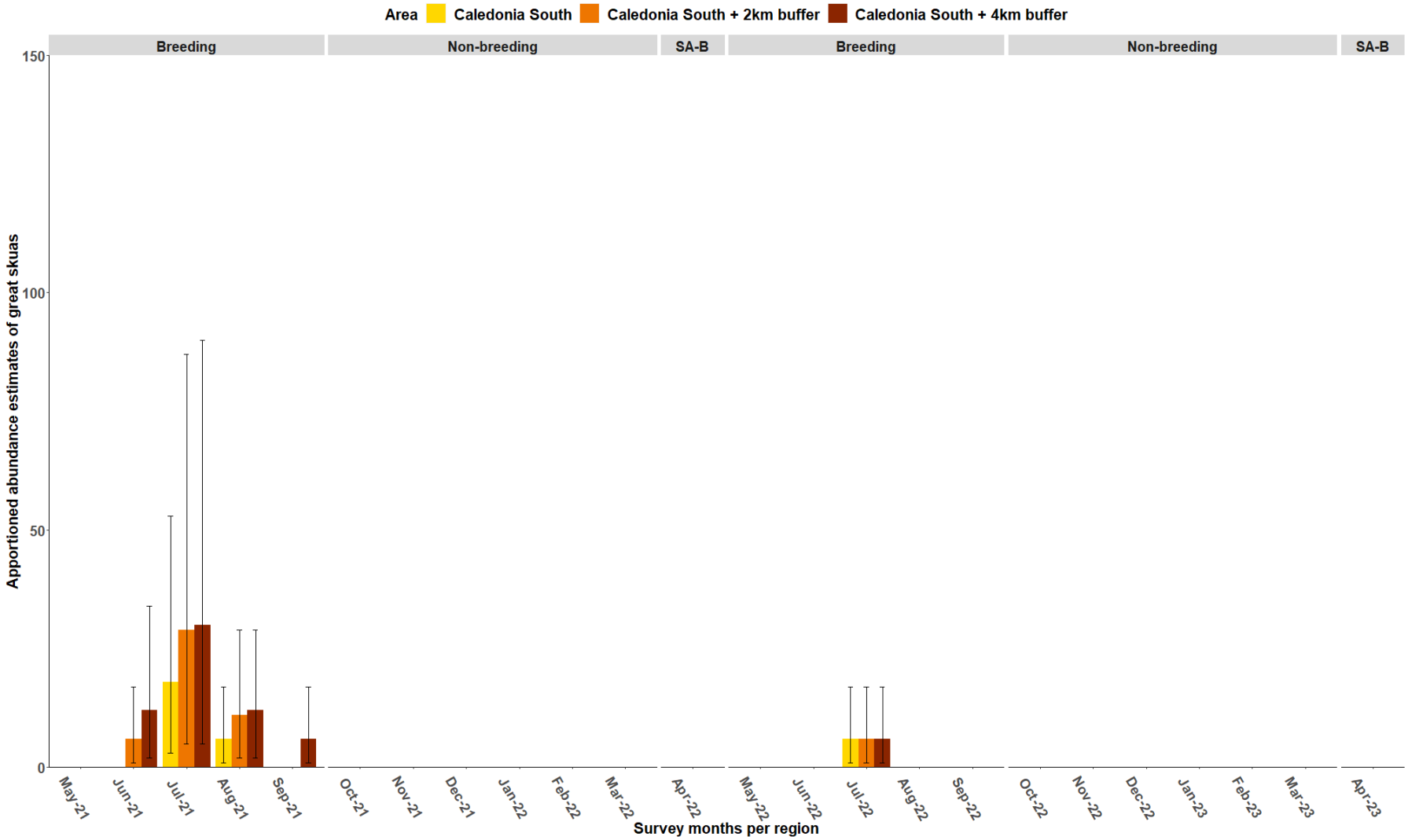
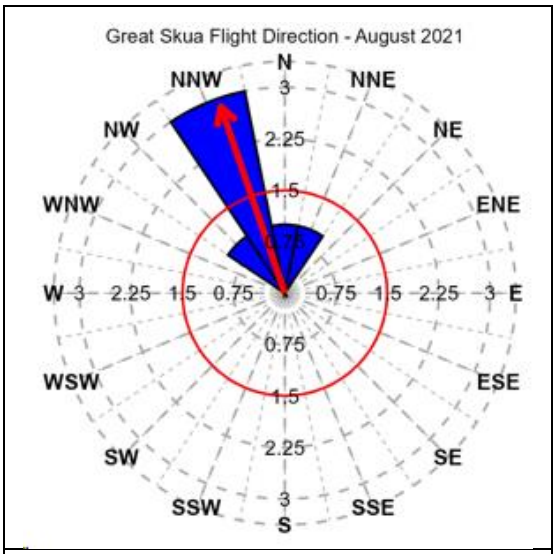



**Figure 18 Bar plot of the monthly apportioned abundances estimates (with 95% confidence intervals) of total great skuas recorded in each reporting region of Caledonia South Survey Area, during the May 2021 to April 2023 survey period. Great skua seasonal periods are also displayed. SA-B corresponds to month split between breeding site attendance (SA) and breeding (B)**

### *ii. Distribution and behaviour*

Maps of distribution are shown in Appendix 4: Figures A4.96-101. In May and June 2021, great skuas were recorded within Caledonia North (Figure A4.96-97). They were recorded both in northern and southern parts of the Survey Area during July and August 2021 with highest numbers across Caledonia North Survey Area and generally more records within Caledonia North (Figure A4.98-99). In September 2021, a single great skua was recorded in the south of Caledonia South buffer (Figure A4.100). Two individuals were recorded in the centre of the Survey Area in July 2022, One within Caledonia North and one within Caledonia South (Figure A4.101).

In August 2021, great skua were recorded flying in a significantly north-northwest direction (Figure 19d). The number of great skuas recorded in flight in any other months were too low to determine a significant flight direction. (Appendix 5, Figure A5.15).




| | |
|---|---|
| Number of Observations | 6 |
| Mean Vector (μ) | 341.279 |
| Length of Mean Vector (r) | 0.957 |
| Rayleigh Test (Z) | 5.499 |
| Rayleigh Test (p) | <0.001 |
| **August 2021** | |

**Figure 19 Summary of flight direction of great skuas within surveys where a significant flight direction was recorded during the May 2021 to April 2023 survey period**

## 4.17 Arctic skua

### i. *Abundance and density estimates*

Two Arctic skuas were recorded in the Survey Area during the second year of the baseline surveys (Table 8). The two individuals were recorded in August 2022 during the breeding season (May to August) (Table 62). These led to unapportioned and apportioned mean abundance estimate of 11 [2; 29] individuals, which equated to a mean density estimate of 0.01 birds/km$^2$ (Table 62).

No Arctic skuas were recorded during the non-breeding season and site attendance period (Table 62).

Measures of precisions were high, which was likely related to the low numbers of individuals recorded in each region (CV > 0.16, Table 62).

**Table 62 Raw counts, unapportioned and apportioned abundance and density estimates (birds per km$^2$) of Arctic skuas in Caledonia OWF, Caledonia OWF plus 2 km buffer and the Survey Area during the May 2021 to April 2023 survey period**

| Survey | Raw count | Total unapportioned | | | | | Total apportioned | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Abundance | LCL | UCL | Precision (CV) | Density (km$^2$) | Abundance | LCL | UCL | Density (km$^2$) |
| **a) Caledonia OWF** | | | | | | | | | | |
| **Aug-22** | 1 | 6 | 1 | 17 | 1.00 | 0.01 | 6 | 1 | 17 | 0.01 |
| **b) Caledonia OWF plus 2 km buffer** | | | | | | | | | | |
| **Aug-22** | 2 | 11 | 2 | 29 | 0.71 | 0.02 | 11 | 2 | 29 | 0.02 |
| **c) Survey Area** | | | | | | | | | | |
| **Aug-22** | 2 | 11 | 2 | 29 | 0.71 | 0.01 | 11 | 2 | 29 | 0.01 |

A single individual was recorded in Caledonia North, resulting in very low abundance and density estimates (Table 63). No Arctic skuas were recorded in Caledonia South, however, two individuals were recorded in the 2 km Buffer Zone of Caledonia South (Table 64). These resulted in an unapportioned and apportioned abundance estimate of 11 [2; 29] individuals, which equated to a mean density estimate of 0.03 birds/km$^2$ (Table 64).

Measures of precisions were high, which was likely related to the low numbers of individuals recorded in each region (CV > 0.16, Table 63 and Table 64).

**Table 63 Raw counts, unapportioned and apportioned abundance and density estimates (birds per km$^2$) of Arctic skuas in Caledonia North, Caledonia North plus 2 km buffer and Caledonia North Survey Area during the May 2021 to April 2023 survey period**

| Survey | Raw count | Total unapportioned | | | | | Total apportioned | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Abundance | LCL | UCL | Precision (CV) | Density (km$^2$) | Abundance | LCL | UCL | Density (km$^2$) |
| **a) Caledonia North** | | | | | | | | | | |
| **Aug-22** | 1 | 6 | 1 | 17 | 1.00 | 0.03 | 6 | 1 | 17 | 0.03 |
| **b) Caledonia North plus 2 km buffer** | | | | | | | | | | |
| **Aug-22** | 1 | 6 | 1 | 17 | 1.00 | 0.02 | 6 | 1 | 17 | 0.02 |
| **c) Caledonia North Survey Area** | | | | | | | | | | |
| **Aug-22** | 1 | 6 | 1 | 17 | 1.00 | 0.01 | 6 | 1 | 17 | 0.01 |

**Table 64 Raw counts, unapportioned and apportioned abundance and density estimates (birds per km$^2$) of Arctic skuas in Caledonia South, Caledonia South plus 2 km buffer and Caledonia South Survey Area during the May 2021 to April 2023 survey period**

| Survey | Raw count | Total unapportioned | | | | | Total apportioned | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Abundance | LCL | UCL | Precision (CV) | Density (km$^2$) | Abundance | LCL | UCL | Density (km$^2$) |
| **a) Caledonia South** | | | | | | | | | | |
| None recorded | | | | | | | | | | |
| **b) Caledonia South plus 2 km buffer** | | | | | | | | | | |
| **Aug-22** | 2 | 11 | 2 | 29 | 0.71 | 0.03 | 11 | 2 | 29 | 0.03 |
| **c) Caledonia South Survey Area** | | | | | | | | | | |
| **Aug-22** | 2 | 11 | 2 | 29 | 0.71 | 0.02 | 11 | 2 | 29 | 0.02 |

### ii. *Distribution and behaviour*

Arctic skuas were only recorded in August 2022, with one individual recorded in the southern tip of Caledonia South Buffer Zone and one recorded in the south of Caledonia North, near the subdivision line with Caledonia South (Appendix 4, Figure A4.102).

As only one bird was recorded in flight, they were too infrequent to determine any preference in flight direction (Appendix 5, Figure A5.16).

## 4.18 Guillemot

### *i. Abundance and density estimates*

#### *Caledonia OWF*

A total of 20,137 guillemots were recorded in the Survey Area during both years of baseline surveys (Table 8). Guillemots were recorded in every survey (Table 8, Table 65). Highest abundances were recorded during the breeding season (April to mid-August), with guillemots attending colonies from February onwards), especially from May to July, with a peak of abundance recorded in May 2022 (Table 65, Figure 20):

- 1,511 individuals were recorded in Caledonia OWF, resulting in an unapportioned mean abundance estimate of 8,755 [5,464; 12,277], an apportioned mean abundance estimate of 9,643 [6,067; 13,857] and an apportioned and availability bias-corrected mean abundance estimate of 12,547 [7,909; 18,015] individuals. These equated to mean density estimates of 20.49 (unapportioned), 22.55 (apportioned) and 29.34 (apportioned and availability bias-corrected) birds/km$^2$.
- 2,388 individuals were recorded in Caledonia OWF plus 2 km buffer, resulting in an unapportioned mean abundance estimate of 13,660 [8,735; 18,866], an apportioned mean abundance estimate of 14,995 [9,648; 20,305] and an apportioned and availability bias-corrected mean abundance estimate of 19,546 [12,599; 26,440] individuals. These equated to mean density estimates of 21.23 (unapportioned), 23.28 (apportioned) and 30.35 (apportioned and availability bias-corrected) birds/km$^2$.
- 3,127 individuals were recorded in the Survey Area, resulting in an unapportioned mean abundance estimate of 18,156 [11,792; 24,548], an apportioned mean abundance estimate of 19,915 [12,794; 27,330] and an apportioned and availability bias-corrected mean abundance estimate of 25,952 [16,690; 35,597] individuals. These equated to mean density estimates of 20.55 (unapportioned), 22.52 (apportioned) and 29.35 (apportioned and availability bias-corrected) birds/km$^2$.

In both breeding seasons covered by the baseline surveys, apportioned and availability bias-corrected mean guillemot abundances across the Survey Area were low at the beginning of the season (i.e. April), and rapidly increased thereafter. Peak abundances occurred either in July (2021) or May (2022), with mean abundances being consistently high throughout May to July in both survey years. Between July and August, apportioned and availability bias-corrected mean guillemot abundances dropped substantially in both breeding seasons covered by the baseline survey period, with low abundances observed in both August 2021 and August 2022. These temporal patterns are indicative of a rapid arrival and departure of birds from the Survey Area close to the start and end of the breeding season. The higher mean abundances in May to July indicate that the Survey Area is likely being used by breeding adults from nearby colonies. Apportioned and availability bias-corrected mean guillemot abundances across the breeding seasons of both 2021 and 2022 were relatively similar, with no obvious significant differences in apportioned and availability bias-corrected mean guillemot abundances between the two seasons.

Reductions in mean apportioned and availability bias-corrected abundance in the breeding season surveys outside the peak survey month (May 2022) varied from 16% to 96%, with most surveys falling somewhere in the middle of the two extremes of this range. This indicates that the mean apportioned abundances were highly variable throughout the breeding season surveys when compared with the peak mean apportioned abundance for this season during the baseline survey period.

During both years of surveys, guillemots were also recorded during the non-breeding period (September to March), albeit in lower numbers than the breeding season, with a wintering peak of abundance in September 2022 (Table 65, Figure 20):

- 390 individuals were recorded in Caledonia OWF, resulting in an unapportioned mean abundance estimate of 2,257 [1,302; 3,455], an apportioned mean abundance estimate of 2,701 [1,556; 4,119] and an apportioned and availability bias-corrected mean abundance estimate of 3,530 [2,037; 5,378] individuals. These equated to mean density estimates of 5.28 (apportioned), 6.32 (unapportioned) and 8.26 (apportioned and availability bias-corrected) birds/km$^2$.
- 1,303 individuals were recorded in Caledonia OWF plus 2 km buffer, resulting in an unapportioned mean abundance estimate of 7,520 [2,170; 17,222], an apportioned mean abundance estimate of 8,710 [2,608; 18,652] and an apportioned and availability bias-corrected mean abundance estimate of 11,408 [3,416; 24,432] individuals. These equated to mean density estimates of 11.69 (unapportioned), 13.52 (apportioned) and 17.71 (apportioned and availability bias-corrected) birds/km$^2$.
- 2,038 individuals were recorded in the Survey Area, resulting in an unapportioned mean abundance estimate of 11,892 [4,476; 22,921], an apportioned mean abundance estimate of 13,436 [5,251; 26,308] and an apportioned and availability bias-corrected mean abundance estimate of 17,603 [6,882; 34,468] individuals. These equated to mean density estimates of 13.46 (unapportioned), 15.19 (apportioned) and 19.90 (apportioned and availability bias-corrected) birds/km$^2$.

During the breeding site attendance period (February and March), guillemots were also recorded in low numbers (lower than the rest of the non-breeding period), with peak numbers in March 2023 (Table 65, Figure 20):

- 289 individuals were recorded in Caledonia OWF, resulting in an unapportioned mean abundance estimate of 1,686 [1,143; 2,223], an apportioned mean abundance estimate of 1,821 [1,209; 2,479] and an apportioned and availability bias-corrected mean abundance estimate of 2,342 [1,570; 3,169] individuals. These equated to mean density estimates of 3.95 (unapportioned), 4.26 (apportioned) and 5.48 (apportioned and availability bias-corrected) birds/km$^2$.
- 406 individuals were recorded in Caledonia OWF plus 2 km buffer, resulting in an unapportioned mean abundance estimate of 2,350 [1,528; 3,144], an apportioned mean abundance estimate of 2,568 [1,611; 3,511] and an apportioned and availability bias-corrected mean abundance estimate of 3,304 [2,093; 4,493] individuals. These equated to mean density estimates of 3.65 (unapportioned), 3.99 (apportioned) and 5.13 (apportioned and availability bias-corrected) birds/km$^2$.
- 503 individuals were recorded in the Survey Area, resulting in an unapportioned mean abundance estimate of 2,953 [2,114; 3,840], an apportioned mean abundance estimate of 3,218 [2,131; 4,278] and an apportioned and availability bias-corrected mean abundance estimate of 4,146 [2,762; 5,487] individuals. These equated to mean density estimates of 3.34 (unapportioned), 3.64 (apportioned) and 4.69 (apportioned and availability bias-corrected) birds/km$^2$.

During the two non-breeding seasons covered by the baseline surveys, peak mean apportioned and availability bias-corrected guillemot abundances within the Survey Area occurred in September, with surveys in other non-breeding season months recording considerably lower equivalent abundances than the overall peak for the two years of surveys, in September 2022. The timing of the non-breeding season peak indicates that post-breeding aggregations of birds, likely from multiple colonies across the wider area, may occur in the Survey Area. Peak mean apportioned and availability bias-corrected guillemot abundances were generally low across the Survey Area during the winter months, with mean

abundances increasing slightly from February in both survey years included in the baseline survey period. This indicates that birds attending nearby breeding colonies prior to the breeding season may be using the Survey Area.

Reductions in mean apportioned and availability bias-corrected abundance relative to the peak for the non-breeding season were between 34% to 99%, with most surveys reporting reductions closer to the upper limit of the range. This indicates that the mean apportioned guillemot abundances were somewhat variable throughout the non-breeding season surveys when compared with the peak mean apportioned abundance for the baseline survey period, with many of the surveys recording mean abundances for this species that were considerably lower than the peak mean apportioned abundance for this seasonal period.

Very good measures of precisions were calculated for most survey months (CV ≤ 0.16; Table 65). Within Caledonia OWF, four surveys out of 24 had precision values of CV > 0.16, of which all were during the non-breeding season, when fewer records of this species were made (Table 65). For Caledonia OWF plus buffer regions, CV values were generally lower than the corresponding CV values for Caledonia OWF, indicating higher precision within these reporting regions (Table 65).

**Table 65** **Raw counts, unapportioned, apportioned and apportioned and availability bias-corrected abundance and density estimates (birds per km$^2$) of guillemots in Caledonia OWF, Caledonia OWF plus 2 km buffer and the Survey Area during the May 2021 to April 2023 survey period. Colour gradients follow the ascending order of guillemot raw counts per season, with light yellow to orange (peak number) for the breeding season months (April to mid-August) and light blue to royal blue (peak number) for the wintering months (September to March). No colours were attributed to the breeding site attendance period (February to March)**

| Survey | Raw count | Total unapportioned | | | | | Total apportioned | | | | Total apportioned and bias-corrected | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Abundance | LCL | UCL | Precision (CV) | Density (km$^2$) | Abundance | LCL | UCL | Density (km$^2$) | Abundance | LCL | UCL | Density (km$^2$) |
| **a) Caledonia OWF** | | | | | | | | | | | | | | |
| **May-21** | 852 | 4,968 | 3,265 | 6,781 | 0.03 | 11.63 | 5,340 | 3,299 | 7,543 | 12.49 | 6,903 | 4,302 | 9,691 | 16.14 |
| **Jun-21** | 481 | 2,823 | 2,143 | 3,604 | 0.05 | 6.61 | 3,476 | 2,251 | 4,944 | 8.13 | 4,390 | 2,869 | 6,220 | 10.27 |
| **Jul-21** | 1,243 | 7,331 | 3,326 | 13,364 | 0.03 | 17.16 | 7,612 | 3,210 | 14,571 | 17.8 | 9,684 | 4,074 | 18,626 | 22.65 |
| **Aug-21** | 45 | 260 | 162 | 353 | 0.15 | 0.61 | 493 | 246 | 837 | 1.15 | 628 | 315 | 1,067 | 1.47 |
| **Sep-21** | 168 | 975 | 627 | 1,346 | 0.08 | 2.28 | 1,344 | 883 | 1,836 | 3.14 | 1,756 | 1,157 | 2,393 | 4.11 |
| **Oct-21** | 93 | 544 | 386 | 725 | 0.10 | 1.27 | 743 | 392 | 1,190 | 1.74 | 943 | 509 | 1,486 | 2.2 |
| **Nov-21** | 158 | 918 | 743 | 1,115 | 0.08 | 2.15 | 1,045 | 794 | 1,348 | 2.44 | 1,349 | 1,036 | 1,720 | 3.15 |
| **Dec-21** | 9 | 52 | 23 | 81 | 0.33 | 0.12 | 346 | 235 | 445 | 0.81 | 454 | 308 | 584 | 1.06 |
| **Jan-22** | 43 | 249 | 87 | 399 | 0.15 | 0.58 | 370 | 149 | 650 | 0.86 | 474 | 194 | 820 | 1.11 |
| **Feb-22** | 62 | 335 | 221 | 443 | 0.13 | 0.78 | 741 | 527 | 974 | 1.73 | 968 | 690 | 1,268 | 2.26 |
| **Mar-22** | 78 | 417 | 235 | 626 | 0.11 | 0.98 | 551 | 244 | 885 | 1.29 | 620 | 284 | 981 | 1.45 |
| **Apr-22** | 167 | 961 | 541 | 1,480 | 0.08 | 2.25 | 1,064 | 470 | 1,731 | 2.49 | 1,235 | 563 | 1,984 | 2.89 |
| **May-22** | **1,511** | **8,755** | **5,464** | **12,277** | **0.03** | **20.49** | **9,643** | **6,067** | **13,857** | **22.55** | **12,547** | **7,909** | **18,015** | **29.34** |
| **Jun-22** | 1,057 | 6,074 | 3,517 | 9,471 | 0.03 | 14.22 | 6,237 | 3,436 | 9,757 | 14.59 | 8,026 | 4,447 | 12,511 | 18.77 |
| **Jul-22** | 834 | 4,878 | 3,170 | 6,551 | 0.03 | 11.42 | 5,357 | 3,089 | 7,912 | 12.53 | 6,758 | 3,889 | 9,958 | 15.8 |
| **Aug-22** | 50 | 288 | 92 | 553 | 0.14 | 0.67 | 338 | 104 | 639 | 0.79 | 441 | 137 | 833 | 1.03 |
| **Sep-22** | **390** | **2,257** | **1,302** | **3,455** | **0.05** | **5.28** | **2,701** | **1,556** | **4,119** | **6.32** | **3,530** | **2,037** | **5,378** | **8.26** |
| **Oct-22** | 27 | 158 | 76 | 251 | 0.19 | 0.37 | 345 | 85 | 835 | 0.81 | 392 | 101 | 930 | 0.92 |
| **Nov-22** | 2 | 12 | 2 | 24 | 0.71 | 0.03 | 55 | 11 | 119 | 0.13 | 72 | 14 | 156 | 0.17 |
| **Dec-22** | 35 | 205 | 117 | 293 | 0.17 | 0.48 | 266 | 139 | 403 | 0.62 | 349 | 183 | 529 | 0.82 |
| **Jan-23** | 68 | 396 | 250 | 547 | 0.12 | 0.93 | 421 | 227 | 634 | 0.98 | 539 | 293 | 806 | 1.26 |
| **Feb-23** | 242 | 1,389 | 809 | 1,940 | 0.06 | 3.25 | 1,503 | 719 | 2,488 | 3.51 | 1,674 | 816 | 2,762 | 3.92 |
| **Mar-23** | 289 | 1,686 | 1,143 | 2,223 | 0.06 | 3.95 | 1,821 | 1,209 | 2,479 | 4.26 | 2,342 | 1,570 | 3,169 | 5.48 |
| **Apr-23** | 317 | 1,797 | 782 | 3,367 | 0.06 | 4.21 | 1,898 | 585 | 4,057 | 4.44 | 2,363 | 727 | 5,062 | 5.53 |
| **b) Caledonia OWF plus 2 km buffer** | | | | | | | | | | | | | | |
| **May-21** | 1,509 | 8,670 | 5,567 | 11,652 | 0.03 | 13.47 | 9,403 | 5,836 | 13,291 | 14.6 | 12,171 | 7,597 | 17,122 | 18.9 |

| Survey | Raw count | Total unapportioned | | | | | Total apportioned | | | | Total apportioned and bias-corrected | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Abundance | LCL | UCL | Precision (CV) | Density ($km^2$) | Abundance | LCL | UCL | Density ($km^2$) | Abundance | LCL | UCL | Density ($km^2$) |
| **Jun-21** | 760 | 4,408 | 3,382 | 5,620 | 0.04 | 6.85 | 5,748 | 3,717 | 8,112 | 8.93 | 7,235 | 4,671 | 10,233 | 11.23 |
| **Jul-21** | 2,014 | 11,666 | 5,237 | 21,740 | 0.02 | 18.13 | 12,191 | 4,804 | 23,466 | 18.93 | 15,538 | 6,068 | 30,106 | 24.12 |
| **Aug-21** | 63 | 360 | 268 | 445 | 0.13 | 0.56 | 819 | 437 | 1,341 | 1.27 | 1,050 | 563 | 1,721 | 1.63 |
| **Sep-21** | 496 | 2,848 | 1,441 | 4,731 | 0.04 | 4.43 | 3,473 | 1,839 | 5,755 | 5.39 | 4,536 | 2,408 | 7,499 | 7.04 |
| **Oct-21** | 163 | 940 | 611 | 1,222 | 0.08 | 1.46 | 1,281 | 705 | 1,872 | 1.99 | 1,620 | 909 | 2,337 | 2.52 |
| **Nov-21** | 282 | 1,613 | 1,270 | 1,899 | 0.06 | 2.51 | 1,756 | 1,349 | 2,253 | 2.73 | 2,270 | 1,758 | 2,891 | 3.52 |
| **Dec-21** | 14 | 80 | 40 | 126 | 0.27 | 0.12 | 611 | 489 | 777 | 0.95 | 800 | 642 | 1,018 | 1.24 |
| **Jan-22** | 66 | 377 | 183 | 577 | 0.12 | 0.59 | 520 | 261 | 868 | 0.81 | 669 | 340 | 1,100 | 1.04 |
| **Feb-22** | 101 | 541 | 338 | 761 | 0.10 | 0.84 | 1,149 | 797 | 1,586 | 1.78 | 1,493 | 1,042 | 2,044 | 2.32 |
| **Mar-22** | 89 | 472 | 271 | 717 | 0.11 | 0.73 | 649 | 311 | 1,038 | 1.01 | 745 | 370 | 1,176 | 1.16 |
| **Apr-22** | 272 | 1,543 | 993 | 2,104 | 0.06 | 2.4 | 1,692 | 925 | 2,539 | 2.63 | 1,942 | 1,052 | 2,922 | 3.02 |
| **May-22** | **2,388** | **13,660** | **8,735** | **18,866** | **0.02** | **21.23** | **14,995** | **9,648** | **20,305** | **23.28** | **19,546** | **12,599** | **26,440** | **30.35** |
| **Jun-22** | 1,758 | 10,073 | 6,434 | 14,622 | 0.02 | 15.65 | 10,338 | 6,037 | 14,935 | 16.05 | 13,314 | 7,816 | 19,161 | 20.67 |
| **Jul-22** | 1,426 | 8,211 | 5,378 | 11,562 | 0.03 | 12.76 | 9,095 | 5,359 | 13,683 | 14.12 | 11,529 | 6,775 | 17,386 | 17.9 |
| **Aug-22** | 112 | 641 | 418 | 904 | 0.09 | 1 | 751 | 458 | 1,094 | 1.17 | 981 | 599 | 1,424 | 1.52 |
| **Sep-22** | **1,303** | **7,520** | **2,170** | **17,222** | **0.03** | **11.69** | **8,710** | **2,608** | **18,652** | **13.52** | **11,408** | **3,416** | **24,432** | **17.71** |
| **Oct-22** | 83 | 484 | 175 | 955 | 0.11 | 0.75 | 858 | 198 | 1,953 | 1.33 | 979 | 234 | 2,216 | 1.52 |
| **Nov-22** | 5 | 29 | 6 | 58 | 0.45 | 0.05 | 73 | 27 | 127 | 0.11 | 94 | 35 | 161 | 0.15 |
| **Dec-22** | 56 | 327 | 239 | 420 | 0.13 | 0.51 | 403 | 267 | 545 | 0.63 | 529 | 350 | 714 | 0.82 |
| **Jan-23** | 106 | 616 | 442 | 796 | 0.10 | 0.96 | 646 | 365 | 978 | 1 | 813 | 470 | 1,212 | 1.26 |
| **Feb-23** | 349 | 1,994 | 1,428 | 2,514 | 0.05 | 3.1 | 2,128 | 1,201 | 3,210 | 3.3 | 2,419 | 1,384 | 3,622 | 3.76 |
| **Mar-23** | 406 | 2,350 | 1,528 | 3,144 | 0.05 | 3.65 | 2,568 | 1,611 | 3,511 | 3.99 | 3,304 | 2,093 | 4,493 | 5.13 |
| **Apr-23** | 416 | 2,359 | 1,145 | 4,134 | 0.05 | 3.67 | 2,510 | 1,119 | 4,726 | 3.9 | 3,137 | 1,404 | 5,919 | 4.87 |
| **c) Survey Area** | | | | | | | | | | | | | | |
| **May-21** | 1,944 | 11,361 | 7,463 | 15,207 | 0.02 | 12.86 | 12,364 | 7,794 | 17,028 | 13.98 | 15,984 | 10,122 | 21,907 | 18.07 |
| **Jun-21** | 1,047 | 6,160 | 4,507 | 8,290 | 0.03 | 6.97 | 8,289 | 4,992 | 12,180 | 9.37 | 10,325 | 6,235 | 15,104 | 11.67 |
| **Jul-21** | 2,687 | 16,223 | 7,656 | 29,307 | 0.02 | 18.36 | 16,935 | 6,934 | 30,203 | 19.15 | 21,670 | 8,828 | 38,770 | 24.5 |
| **Aug-21** | 115 | 667 | 545 | 801 | 0.09 | 0.75 | 2,229 | 1,136 | 3,440 | 2.52 | 2,886 | 1,471 | 4,455 | 3.26 |
| **Sep-21** | 808 | 4,729 | 2,400 | 7,474 | 0.04 | 5.35 | 5,717 | 2,989 | 9,335 | 6.46 | 7,470 | 3,915 | 12,182 | 8.45 |
| **Oct-21** | 266 | 1,557 | 1,036 | 2,107 | 0.06 | 1.76 | 2,079 | 1,215 | 3,066 | 2.35 | 2,650 | 1,575 | 3,866 | 3 |
| **Nov-21** | 421 | 2,451 | 1,839 | 3,010 | 0.05 | 2.77 | 2,643 | 1,938 | 3,388 | 2.99 | 3,427 | 2,528 | 4,373 | 3.88 |
| **Dec-21** | 18 | 105 | 58 | 163 | 0.24 | 0.12 | 1,026 | 804 | 1,324 | 1.16 | 1,330 | 1,052 | 1,692 | 1.5 |

| Survey | Raw count | Total unapportioned | | | | | Total apportioned | | | | Total apportioned and bias-corrected | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Abundance | LCL | UCL | Precision (CV) | Density ($km^2$) | Abundance | LCL | UCL | Density ($km^2$) | Abundance | LCL | UCL | Density ($km^2$) |
| **Jan-22** | 88 | 510 | 267 | 771 | 0.11 | 0.58 | 705 | 373 | 1,100 | 0.8 | 906 | 486 | 1,393 | 1.02 |
| **Feb-22** | 145 | 796 | 478 | 1,109 | 0.08 | 0.9 | 1,616 | 1,038 | 2,269 | 1.83 | 2,099 | 1,356 | 2,932 | 2.37 |
| **Mar-22** | 130 | 702 | 438 | 1,010 | 0.09 | 0.79 | 963 | 477 | 1,493 | 1.09 | 1,127 | 571 | 1,734 | 1.27 |
| **Apr-22** | 448 | 2,583 | 1,586 | 3,880 | 0.05 | 2.92 | 2,781 | 1,511 | 4,163 | 3.15 | 3,110 | 1,685 | 4,663 | 3.52 |
| **May-22** | 3,127 | 18,156 | 11,792 | 24,548 | 0.02 | 20.55 | 19,915 | 12,794 | 27,330 | 22.52 | 25,952 | 16,690 | 35,597 | 29.35 |
| **Jun-22** | 2,299 | 13,305 | 8,502 | 18,497 | 0.02 | 15.06 | 13,652 | 8,091 | 19,710 | 15.44 | 17,522 | 10,446 | 25,198 | 19.81 |
| **Jul-22** | 2,595 | 15,167 | 9,088 | 22,823 | 0.02 | 17.16 | 16,462 | 8,689 | 25,204 | 18.61 | 21,055 | 11,048 | 32,308 | 23.81 |
| **Aug-22** | 157 | 902 | 586 | 1,241 | 0.08 | 1.02 | 1,086 | 683 | 1,547 | 1.23 | 1,420 | 895 | 2,018 | 1.61 |
| **Sep-22** | 2,038 | 11,892 | 4,476 | 22,921 | 0.02 | 13.46 | 13,436 | 5,251 | 26,308 | 15.19 | 17,603 | 6,882 | 34,468 | 19.9 |
| **Oct-22** | 116 | 682 | 259 | 1,252 | 0.09 | 0.77 | 1,184 | 249 | 2,487 | 1.34 | 1,369 | 296 | 2,870 | 1.55 |
| **Nov-22** | 15 | 88 | 35 | 153 | 0.26 | 0.1 | 180 | 85 | 308 | 0.2 | 229 | 110 | 390 | 0.26 |
| **Dec-22** | 81 | 478 | 318 | 637 | 0.11 | 0.54 | 576 | 366 | 782 | 0.65 | 755 | 480 | 1,025 | 0.85 |
| **Jan-23** | 147 | 864 | 582 | 1,153 | 0.08 | 0.98 | 900 | 548 | 1,346 | 1.02 | 1,140 | 704 | 1,688 | 1.29 |
| **Feb-23** | 448 | 2,594 | 1,673 | 3,492 | 0.05 | 2.94 | 2,782 | 1,595 | 4,203 | 3.15 | 3,176 | 1,844 | 4,762 | 3.59 |
| **Mar-23** | 503 | 2,953 | 2,114 | 3,840 | 0.04 | 3.34 | 3,218 | 2,131 | 4,278 | 3.64 | 4,146 | 2,762 | 5,487 | 4.69 |
| **Apr-23** | 494 | 2,835 | 1,561 | 4,758 | 0.04 | 3.21 | 3,011 | 1,536 | 5,333 | 3.4 | 3,739 | 1,901 | 6,642 | 4.23 |

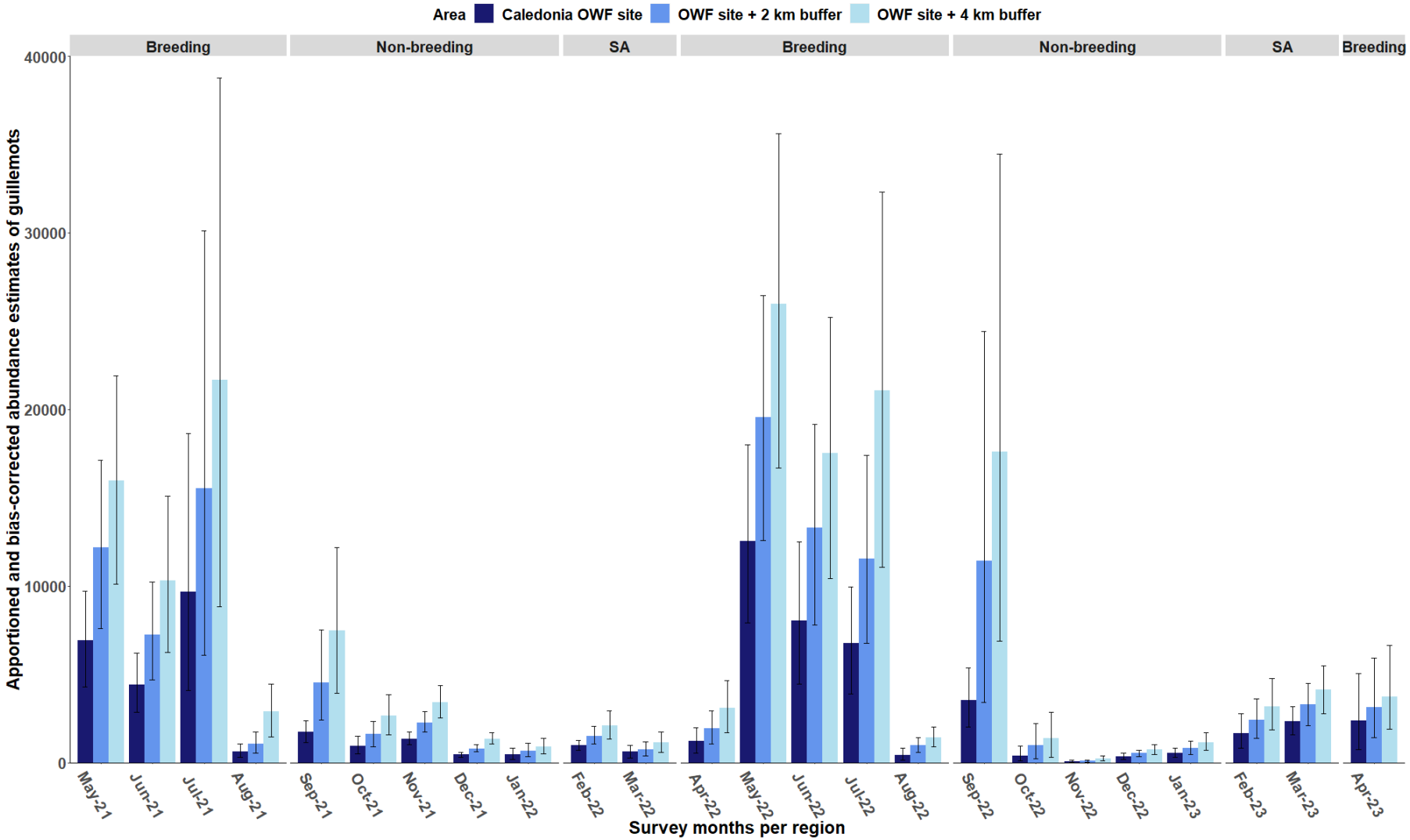



**Figure 20 Bar plot of the monthly apportioned and availability bias-corrected abundance estimates (with 95% confidence intervals) of total guillemots recorded in each reporting region of the Survey Area, during the May 2021 to April 2023 survey period. Guillemot seasonal periods are also displayed. SA stands for breeding site attendance**

### *Caledonia North*

A total of 7,661 guillemots were recorded in Caledonia North Survey Area during both years of baseline surveys (Table 9). Guillemots were recorded in every survey (Table 9, Table 66). Highest abundances were recorded during the breeding season (April to mid-August, with birds attending colonies from February onwards), especially from May to July, with a peak of abundance in May 2022 (Table 66, Figure 21):

- 852 individuals were recorded in Caledonia North, resulting in an unapportioned mean abundance estimate of 4,944 [2,774; 7,515], an apportioned mean abundance estimate of 5,420 [2,764; 8,827] and an apportioned and availability bias-corrected mean abundance estimate of 7,019 [3,578; 11,441] individuals. These equated to mean density estimates of 22.64 (unapportioned), 24.81 (apportioned) and 32.12 (apportioned and availability bias-corrected) birds/km$^2$.
- 1,597 individuals were recorded in Caledonia North plus 2 km buffer, resulting in an unapportioned mean abundance estimate of 9,095 [5,888; 12,528], an apportioned mean abundance estimate of 9,965 [6,132; 14,072] and an apportioned and availability bias-corrected mean abundance estimate of 12,962 [7,988; 18,287] individuals. These equated to mean density estimates of 24.23 (unapportioned), 26.53 (apportioned) and 34.51 (apportioned and availability bias-corrected) birds/km$^2$.
- 2,284 individuals were recorded in Caledonia North Survey Area, resulting in an unapportioned mean abundance estimate of 13,280 [8,902; 18,176], an apportioned mean abundance estimate of 14,493 [9,513; 20,016] and an apportioned and availability bias-corrected mean abundance estimate of 18,859 [12,395; 26,032] individuals. These equated to mean density estimates of 23.84 (unapportioned), 26.00 (apportioned) and 33.83 (apportioned and availability bias-corrected) birds/km$^2$.

In both breeding seasons covered by the baseline surveys, apportioned and availability bias-corrected mean guillemot abundances across Caledonia North Survey Area were low at the beginning of the season (i.e. April), and rapidly increased thereafter. Peak abundances occurred either in July (2021) or May (2022). In 2021, mean abundances were relatively similar between May and July, whilst in 2022, a large peak was observed in May 2022, with relatively stable mean abundances being recorded across much of Caledonia North Survey Area in June and July 2022. Between July and August in both years covered by the baseline surveys, apportioned and availability bias-corrected mean guillemot abundances dropped substantially, with low abundances observed in both August 2021 and August 2022. These temporal patterns are indicative of a rapid arrival and departure of birds from Caledonia North Survey Area close to the start and end of the breeding season. The higher mean abundances in May to July indicate that Caledonia North Survey Area is likely being used by breeding adults from nearby colonies. Overall, excluding the overall peak for the breeding season apportioned and availability bias-corrected mean guillemot abundances in May 2022, abundances were relatively similar across the two breeding seasons covered by the baseline survey period.

Reductions in mean apportioned and availability bias-corrected abundance in the breeding season surveys outside the peak survey month varied from 55% to 99%, with most surveys falling somewhere in the middle of the two extremes of this range. This indicates that the mean apportioned abundances were somewhat variable throughout the breeding season surveys when compared with the peak mean apportioned abundance for this season during the baseline survey period.

During both years of surveys, guillemots were recorded during the non-breeding period (September to March) in considerably lower numbers than the breeding season. Excluding the January to February period, where nest attendance commonly occurs in this species, the wintering peak abundance was recorded in November 2021 (Table 66, Figure 21):

- 62 individuals were recorded in Caledonia North, resulting in an unapportioned mean abundance estimate of 362 [257; 479], an apportioned mean abundance estimate of 428 [268; 626] and an apportioned and availability bias-corrected mean abundance estimate of 552 [350; 797] individuals. These equated to mean density estimates of 1.66 (unapportioned), 1.96 (apportioned) and 2.53 (apportioned and availability bias-corrected) birds/km$^2$.
- 119 individuals were recorded in Caledonia North plus 2 km buffer, resulting in an unapportioned mean abundance estimate of 679 [411; 1,004], an apportioned mean abundance estimate of 752 [450; 1,169] and an apportioned and availability bias-corrected mean abundance estimate of 977 [588; 1,508] individuals. These equated to mean density estimates of 1.81 (unapportioned), 2.00 (apportioned) and 2.60 (apportioned and availability bias-corrected) birds/km$^2$.
- 180 individuals were recorded in Caledonia North Survey Area, resulting in an unapportioned mean abundance estimate of 1,051 [771; 1,390], an apportioned mean abundance estimate of 1,162 [796; 1,641] and an apportioned and availability bias-corrected mean abundance estimate of 1,509 [1,041; 2,117] individuals. These equated to mean density estimates of 1.89 (unapportioned), 2.08 (apportioned) and 2.71 (apportioned and availability bias-corrected) birds/km$^2$.

During the breeding site attendance period (February and March), guillemots were recorded in low numbers (though in higher peak numbers than the rest of the non-breeding season, in contrast to the Survey Area), with peak numbers in March 2023 (Table 66, Figure 21):

- 132 individuals were recorded in Caledonia North, resulting in an unapportioned mean abundance estimate of 774 [522; 1,031], an apportioned mean abundance estimate of 866 [552; 1,212] and an apportioned and availability bias-corrected mean abundance estimate of 1,110 [718; 1,532] individuals. These equated to mean density estimates of 3.55 (unapportioned), 3.97 (apportioned) and 5.08 (apportioned and availability bias-corrected) birds/km$^2$.
- 232 individuals were recorded in Caledonia North plus 2 km buffer, resulting in an unapportioned mean abundance estimate of 1,345 [957; 1,780], an apportioned mean abundance estimate of 1,489 [1,032; 2,054] and an apportioned and availability bias-corrected mean abundance estimate of 1,918 [1,346; 2,615] individuals. These equated to mean density estimates of 3.58 (unapportioned), 3.97 (apportioned) and 5.11 (apportioned and availability bias-corrected) birds/km$^2$.
- 316 individuals were recorded in Caledonia North Survey Area, resulting in an unapportioned mean abundance estimate of 1,856 [1,339; 2,408], an apportioned mean abundance estimate of 2,033 [1,355; 2,783] and an apportioned and availability bias-corrected mean abundance estimate of 2,620 [1,759; 3,561] individuals. These equated to mean density estimates of 3.33 (unapportioned), 3.65 (apportioned) and 4.70 (apportioned and availability bias-corrected) birds/km$^2$.

During the two non-breeding seasons covered by the baseline surveys, mean apportioned and availability bias-corrected guillemot abundances were consistently low within Caledonia North Survey Area, with the overall peak for this period occurring in November 2021, excluding the pre-breeding season colony attendance period. The autumnal peaks in mean apportioned and availability bias-corrected guillemot abundances observed within the Survey Area and Caledonia South Survey Area were not recorded to the same extent within Caledonia North Survey Area, indicating a possible lower importance of Caledonia North Survey Area to this species during the autumn. Peak mean apportioned

and availability bias-corrected guillemot abundances were generally low across Caledonia North Survey Area during the winter months, with mean abundances increasing slightly from February in both survey years included in the baseline survey period. This indicates that birds attending nearby breeding colonies prior to the breeding season may be using Caledonia North Survey Area.

Reductions in mean apportioned and availability bias-corrected abundance relative to the peak were between 14% to 95%, with most surveys reporting reductions in the middle of the extremes of the range. This indicates that the mean apportioned abundances were highly variable throughout the breeding season surveys when compared with the peak mean apportioned abundance for this season during the baseline survey period.

Good measures of precisions were calculated for most survey months (CV ≤ 0.16; Table 66). Within Caledonia North, 12 surveys out of 24 had precision values of CV ≤ 0.16, and most surveys during the breeding season (seven of ten) had CV values of ≤ 0.16. CV values during the non-breeding season were higher (more often in the region of 0.2 to 0.5), indicating lower levels of precision when compared with breeding season surveys (Table 66). For Caledonia North plus buffer regions, CV values were generally lower than the corresponding CV values for Caledonia North, indicating higher precision within these reporting regions (Table 66).

**Table 66** **Raw counts, unapportioned, apportioned and apportioned and availability bias-corrected abundance and density estimates (birds per km$^2$) of guillemots in Caledonia North, Caledonia North plus 2 km buffer and Caledonia North Survey Area during the May 2021 to April 2023 survey period. Colour gradients follow the ascending order of guillemot raw counts per season, with light yellow to orange (peak number) for the breeding season months (April to mid-August) and light blue to royal blue (peak number) for the wintering months (September to March). No colours were attributed to the breeding site attendance period (February to March)**

| Survey | Raw count | Total unapportioned | | | | | Total apportioned | | | | Total apportioned and bias-corrected | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Abundance | LCL | UCL | Precision (CV) | Density (km$^2$) | Abundance | LCL | UCL | Density (km$^2$) | Abundance | LCL | UCL | Density (km$^2$) |
| **a) Caledonia North** | | | | | | | | | | | | | | |
| **May-21** | 276 | 1,609 | 787 | 2,956 | 0.06 | 7.37 | 1,748 | 797 | 3,150 | 8.00 | 2,228 | 1,025 | 4,013 | 10.2 |
| **Jun-21** | 179 | 1,058 | 786 | 1,342 | 0.07 | 4.85 | 1,245 | 835 | 1,639 | 5.70 | 1,564 | 1,056 | 2,052 | 7.16 |
| **Jul-21** | 317 | 1,877 | 1,006 | 3,836 | 0.06 | 8.60 | 1,968 | 970 | 3,137 | 9.01 | 2,362 | 1,173 | 3,744 | 10.81 |
| **Aug-21** | 11 | 64 | 29 | 104 | 0.30 | 0.29 | 78 | 32 | 129 | 0.36 | 89 | 38 | 146 | 0.41 |
| **Sep-21** | 37 | 214 | 156 | 284 | 0.16 | 0.98 | 326 | 192 | 512 | 1.49 | 422 | 251 | 656 | 1.93 |
| **Oct-21** | 16 | 93 | 41 | 152 | 0.25 | 0.43 | 172 | 56 | 347 | 0.79 | 202 | 69 | 395 | 0.93 |
| **Nov-21** | 62 | 362 | 257 | 479 | 0.13 | 1.66 | 428 | 268 | 626 | 1.96 | 552 | 350 | 797 | 2.53 |
| **Dec-21** | 5 | 29 | 12 | 46 | 0.45 | 0.13 | 136 | 57 | 215 | 0.62 | 178 | 74 | 281 | 0.81 |
| **Jan-22** | 7 | 40 | 12 | 75 | 0.38 | 0.18 | 93 | 22 | 219 | 0.43 | 111 | 27 | 255 | 0.51 |
| **Feb-22** | 23 | 124 | 43 | 205 | 0.21 | 0.57 | 288 | 106 | 458 | 1.32 | 376 | 139 | 595 | 1.72 |
| **Mar-22** | 24 | 128 | 69 | 197 | 0.20 | 0.59 | 172 | 54 | 341 | 0.79 | 201 | 67 | 393 | 0.92 |
| **Apr-22** | 79 | 454 | 281 | 666 | 0.11 | 2.08 | 476 | 160 | 847 | 2.18 | 526 | 183 | 925 | 2.41 |
| **May-22** | 852 | 4,944 | 2,774 | 7,515 | 0.03 | 22.64 | 5,420 | 2,764 | 8,827 | 24.81 | 7,019 | 3,578 | 11,441 | 32.12 |
| **Jun-22** | 325 | 1,851 | 826 | 3,121 | 0.06 | 8.48 | 1,890 | 833 | 3,282 | 8.65 | 2,378 | 1,067 | 4,095 | 10.88 |
| **Jul-22** | 217 | 1,271 | 1,013 | 1,557 | 0.07 | 5.82 | 1,424 | 998 | 1,855 | 6.52 | 1,752 | 1,253 | 2,251 | 8.02 |
| **Aug-22** | 5 | 29 | 6 | 58 | 0.45 | 0.13 | 39 | 10 | 76 | 0.18 | 51 | 13 | 100 | 0.24 |
| **Sep-22** | 53 | 304 | 161 | 453 | 0.14 | 1.39 | 390 | 205 | 579 | 1.78 | 511 | 269 | 759 | 2.34 |
| **Oct-22** | 2 | 12 | 2 | 23 | 0.71 | 0.05 | 21 | 4 | 60 | 0.10 | 26 | 4 | 73 | 0.12 |
| **Nov-22** | 1 | 6 | 1 | 18 | 1.00 | 0.03 | 34 | 6 | 89 | 0.15 | 44 | 7 | 116 | 0.2 |
| **Dec-22** | 14 | 81 | 41 | 151 | 0.27 | 0.37 | 106 | 46 | 215 | 0.49 | 139 | 60 | 282 | 0.64 |
| **Jan-23** | 27 | 156 | 75 | 243 | 0.19 | 0.71 | 170 | 62 | 299 | 0.78 | 221 | 81 | 386 | 1.01 |
| **Feb-23** | 116 | 669 | 311 | 1,066 | 0.09 | 3.06 | 717 | 286 | 1,205 | 3.28 | 768 | 315 | 1,281 | 3.51 |
| **Mar-23** | 132 | 774 | 522 | 1,031 | 0.09 | 3.55 | 866 | 552 | 1,212 | 3.97 | 1,110 | 718 | 1,532 | 5.08 |
| **Apr-23** | 26 | 147 | 90 | 203 | 0.20 | 0.67 | 170 | 61 | 336 | 0.78 | 205 | 75 | 402 | 0.94 |
| **b) Caledonia North plus 2 km buffer** | | | | | | | | | | | | | | |
| **May-21** | 380 | 2,173 | 995 | 3,758 | 0.05 | 5.79 | 2,395 | 1,112 | 4,280 | 6.38 | 3,034 | 1,421 | 5,406 | 8.08 |

| Survey | Raw count | Total unapportioned | | | | | Total apportioned | | | | Total apportioned and bias-corrected | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Abundance | LCL | UCL | Precision (CV) | Density (km$^2$) | Abundance | LCL | UCL | Density (km$^2$) | Abundance | LCL | UCL | Density (km$^2$) |
| **Jun-21** | 275 | 1,593 | 1,077 | 2,056 | 0.06 | 4.24 | 1,857 | 1,182 | 2,544 | 4.94 | 2,333 | 1,495 | 3,184 | 6.21 |
| **Jul-21** | 623 | 3,591 | 2,525 | 4,727 | 0.04 | 9.57 | 3,735 | 2,218 | 5,466 | 9.95 | 4,555 | 2,721 | 6,657 | 12.13 |
| **Aug-21** | 20 | 113 | 62 | 170 | 0.22 | 0.30 | 143 | 48 | 275 | 0.38 | 168 | 56 | 327 | 0.45 |
| **Sep-21** | 65 | 370 | 250 | 489 | 0.12 | 0.99 | 595 | 360 | 897 | 1.58 | 766 | 470 | 1,136 | 2.04 |
| **Oct-21** | 30 | 171 | 80 | 269 | 0.18 | 0.46 | 273 | 100 | 502 | 0.73 | 328 | 126 | 583 | 0.87 |
| **Nov-21** | **119** | **679** | **411** | **1,004** | **0.09** | **1.81** | **752** | **450** | **1,169** | **2.00** | **977** | **588** | **1,508** | **2.6** |
| **Dec-21** | 5 | 28 | 6 | 57 | 0.45 | 0.07 | 244 | 134 | 320 | 0.65 | 320 | 175 | 420 | 0.85 |
| **Jan-22** | 21 | 119 | 57 | 216 | 0.22 | 0.32 | 191 | 75 | 378 | 0.51 | 237 | 96 | 459 | 0.63 |
| **Feb-22** | 34 | 182 | 86 | 279 | 0.17 | 0.48 | 430 | 203 | 679 | 1.14 | 558 | 266 | 877 | 1.49 |
| **Mar-22** | 31 | 165 | 85 | 244 | 0.18 | 0.44 | 218 | 75 | 406 | 0.58 | 249 | 88 | 464 | 0.66 |
| **Apr-22** | 119 | 669 | 433 | 933 | 0.09 | 1.78 | 719 | 331 | 1,173 | 1.91 | 810 | 377 | 1,311 | 2.16 |
| **May-22** | **1,597** | **9,095** | **5,888** | **12,528** | **0.03** | **24.23** | **9,965** | **6,132** | **14,072** | **26.53** | **12,962** | **7,988** | **18,287** | **34.51** |
| **Jun-22** | 657 | 3,790 | 2,394 | 5,261 | 0.04 | 10.10 | 3,899 | 2,273 | 5,773 | 10.38 | 4,919 | 2,905 | 7,221 | 13.1 |
| **Jul-22** | 402 | 2,301 | 1,603 | 3,022 | 0.05 | 6.13 | 2,541 | 1,583 | 3,589 | 6.76 | 3,078 | 1,937 | 4,314 | 8.2 |
| **Aug-22** | 20 | 114 | 40 | 212 | 0.22 | 0.30 | 151 | 46 | 290 | 0.40 | 198 | 61 | 380 | 0.53 |
| **Sep-22** | 73 | 424 | 244 | 610 | 0.12 | 1.13 | 536 | 294 | 813 | 1.43 | 703 | 385 | 1,066 | 1.87 |
| **Oct-22** | 21 | 123 | 21 | 323 | 0.22 | 0.33 | 295 | 50 | 779 | 0.79 | 303 | 52 | 795 | 0.81 |
| **Nov-22** | 3 | 17 | 3 | 46 | 0.58 | 0.05 | 50 | 12 | 116 | 0.13 | 64 | 15 | 147 | 0.17 |
| **Dec-22** | 25 | 147 | 82 | 218 | 0.20 | 0.39 | 195 | 94 | 306 | 0.52 | 255 | 124 | 401 | 0.68 |
| **Jan-23** | 42 | 246 | 147 | 352 | 0.15 | 0.66 | 267 | 134 | 422 | 0.71 | 348 | 175 | 548 | 0.93 |
| **Feb-23** | 166 | 947 | 513 | 1,460 | 0.08 | 2.52 | 1,001 | 483 | 1,584 | 2.66 | 1,082 | 532 | 1,704 | 2.88 |
| **Mar-23** | 232 | 1,345 | 957 | 1,780 | 0.07 | 3.58 | 1,489 | 1,032 | 2,054 | 3.97 | 1,918 | 1,346 | 2,615 | 5.11 |
| **Apr-23** | 58 | 331 | 269 | 406 | 0.13 | 0.88 | 399 | 220 | 611 | 1.06 | 491 | 275 | 746 | 1.31 |
| **c) Caledonia North Survey Area** | | | | | | | | | | | | | | |
| **May-21** | 560 | 3,278 | 1,879 | 5,104 | 0.04 | 5.88 | 3,659 | 1,987 | 5,772 | 6.56 | 4,635 | 2,536 | 7,272 | 8.31 |
| **Jun-21** | 385 | 2,277 | 1,485 | 3,052 | 0.05 | 4.09 | 2,686 | 1,654 | 3,756 | 4.82 | 3,357 | 2,075 | 4,683 | 6.02 |
| **Jul-21** | 993 | 6,013 | 3,730 | 9,077 | 0.03 | 10.79 | 6,305 | 3,380 | 10,219 | 11.31 | 7,833 | 4,214 | 12,743 | 14.05 |
| **Aug-21** | 38 | 221 | 122 | 314 | 0.16 | 0.40 | 312 | 164 | 458 | 0.56 | 380 | 201 | 557 | 0.68 |
| **Sep-21** | 112 | 654 | 508 | 800 | 0.09 | 1.17 | 1,004 | 688 | 1,374 | 1.80 | 1,296 | 899 | 1,749 | 2.32 |
| **Oct-21** | 64 | 374 | 210 | 573 | 0.13 | 0.67 | 568 | 257 | 1,008 | 1.02 | 698 | 327 | 1,216 | 1.25 |
| **Nov-21** | **180** | **1,051** | **771** | **1,390** | **0.07** | **1.89** | **1,162** | **796** | **1,641** | **2.08** | **1,509** | **1,041** | **2,117** | **2.71** |
| **Dec-21** | 9 | 52 | 29 | 76 | 0.33 | 0.09 | 463 | 304 | 647 | 0.83 | 592 | 396 | 804 | 1.06 |

| Survey | Raw count | Total unapportioned | | | | | Total apportioned | | | | Total apportioned and bias-corrected | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Abundance | LCL | UCL | Precision (CV) | Density ($km^2$) | Abundance | LCL | UCL | Density ($km^2$) | Abundance | LCL | UCL | Density ($km^2$) |
| **Jan-22** | 41 | 237 | 139 | 336 | 0.16 | 0.43 | 351 | 158 | 599 | 0.63 | 445 | 204 | 746 | 0.8 |
| **Feb-22** | 46 | 253 | 127 | 407 | 0.15 | 0.45 | 577 | 281 | 910 | 1.03 | 741 | 366 | 1,160 | 1.33 |
| **Mar-22** | 45 | 243 | 140 | 367 | 0.15 | 0.44 | 349 | 147 | 600 | 0.63 | 407 | 177 | 691 | 0.73 |
| **Apr-22** | 170 | 979 | 599 | 1,370 | 0.08 | 1.76 | 1,048 | 510 | 1,626 | 1.88 | 1,193 | 582 | 1,846 | 2.14 |
| **May-22** | 2,284 | 13,280 | 8,902 | 18,176 | 0.02 | 23.84 | 14,493 | 9,513 | 20,016 | 26.00 | 18,859 | 12,395 | 26,032 | 33.83 |
| **Jun-22** | 1,127 | 6,512 | 4,172 | 8,985 | 0.03 | 11.69 | 6,727 | 3,720 | 9,986 | 12.07 | 8,516 | 4,773 | 12,509 | 15.27 |
| **Jul-22** | 702 | 4,109 | 2,967 | 5,256 | 0.04 | 7.38 | 4,462 | 2,684 | 6,462 | 8.00 | 5,493 | 3,312 | 7,953 | 9.85 |
| **Aug-22** | 28 | 160 | 63 | 269 | 0.19 | 0.29 | 230 | 92 | 402 | 0.41 | 301 | 120 | 527 | 0.54 |
| **Sep-22** | 101 | 588 | 326 | 874 | 0.10 | 1.06 | 724 | 367 | 1,087 | 1.30 | 947 | 481 | 1,419 | 1.7 |
| **Oct-22** | 25 | 147 | 25 | 352 | 0.20 | 0.26 | 435 | 80 | 1,011 | 0.78 | 452 | 84 | 1,041 | 0.81 |
| **Nov-22** | 4 | 24 | 4 | 53 | 0.50 | 0.04 | 61 | 16 | 117 | 0.11 | 78 | 20 | 145 | 0.14 |
| **Dec-22** | 44 | 259 | 147 | 389 | 0.15 | 0.46 | 333 | 167 | 511 | 0.60 | 436 | 219 | 669 | 0.78 |
| **Jan-23** | 62 | 366 | 212 | 531 | 0.13 | 0.66 | 389 | 187 | 621 | 0.70 | 500 | 242 | 794 | 0.9 |
| **Feb-23** | 201 | 1,161 | 555 | 1,750 | 0.07 | 2.08 | 1,287 | 565 | 2,174 | 2.31 | 1,408 | 633 | 2,348 | 2.53 |
| **Mar-23** | 316 | 1,856 | 1,339 | 2,408 | 0.06 | 3.33 | 2,033 | 1,355 | 2,783 | 3.65 | 2,620 | 1,759 | 3,561 | 4.7 |
| **Apr-23** | 124 | 710 | 470 | 974 | 0.09 | 1.27 | 795 | 432 | 1,206 | 1.43 | 959 | 523 | 1,449 | 1.72 |

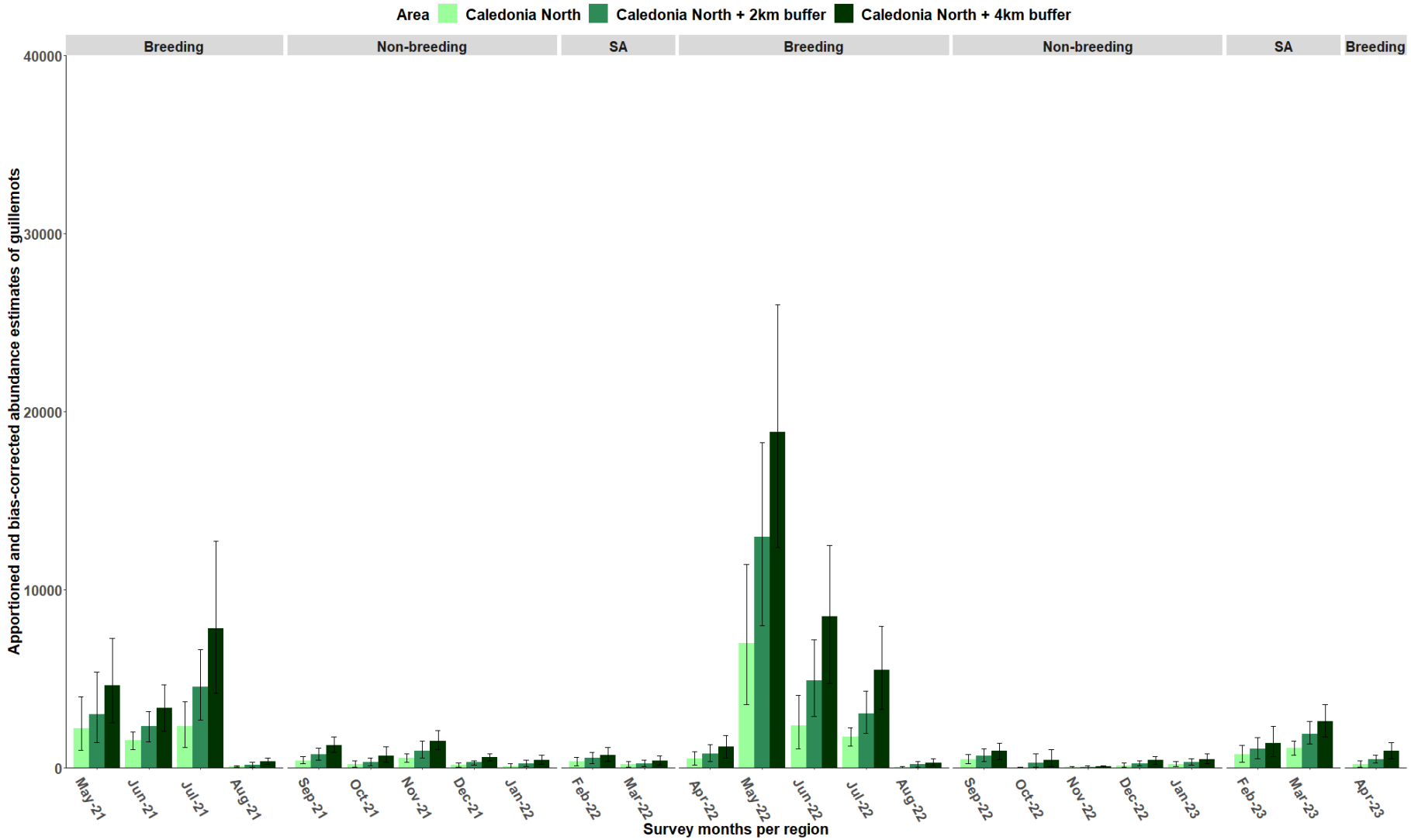



**Figure 21 Bar plot of the monthly apportioned and availability bias-corrected abundance estimates (with 95% confidence intervals) of total guillemots recorded in each reporting region of Caledonia North Survey Area, during the May 2021 to April 2023 survey period. Guillemot seasonal periods are also displayed. SA stands for breeding site attendance**

### *Caledonia South*

A total of 15,579 guillemots were recorded in Caledonia South Survey Area during both years of baseline surveys (Table 10). Guillemots were recorded in every survey (Table 10, Table 67). Highest abundances were recorded during the breeding season (April to mid-August, with birds attending colonies from February onwards), especially from May to July, with a peak of abundance in July 2021 in Caledonia South and Caledonia South plus 2 km buffer, and in July 2022 for Caledonia South Survey Area (Table 67, Figure 22):

- 947 individuals were recorded in Caledonia South in July 2021, resulting in an unapportioned mean abundance estimate of 5,554 [1,771; 11,735], an apportioned mean abundance estimate of 5,748 [1,733; 12,403] and an apportioned and availability bias-corrected mean abundance estimate of 7,457 [2,224; 16,152] individuals. These equated to mean density estimates of 26.41 (unapportioned), 27.31 (apportioned) and 35.43 (apportioned and availability bias-corrected) birds/km$^2$.
- 1,563 individuals were recorded in Caledonia South plus 2 km buffer in July 2021, resulting in an unapportioned mean abundance estimate of 9,094 [2,868; 19,305], an apportioned mean abundance estimate of 9,525 [3,142; 20,132] and an apportioned and availability bias-corrected mean abundance estimate of 12,351 [4,037; 26,194] individuals. These equated to mean density estimates of 25.30 (unapportioned), 26.48 (apportioned) and 34.33 (apportioned and availability bias-corrected) birds/km$^2$.
- 2,278 individuals were recorded in Caledonia South Survey Area in July 2022, resulting in an unapportioned mean abundance estimate of 13,189 [6,924; 20,611], an apportioned mean abundance estimate of 14,246 [6,710; 23,854] and an apportioned and availability bias-corrected mean abundance estimate of 18,392 [8,622; 30,838] individuals. These equated to mean density estimates of 24.73 (unapportioned), 26.69 (apportioned) and 34.46 (apportioned and availability bias-corrected) birds/km$^2$.

In both breeding seasons covered by the baseline surveys, apportioned and availability bias-corrected mean guillemot abundances across Caledonia South Survey Area were low at the beginning of the season (i.e. April), and rapidly increased thereafter. Peak abundances occurred in July in both the 2021 and 2022 breeding seasons, though apportioned and availability bias-corrected mean guillemot abundances were consistently high throughout May, June and July in both survey years. Between July and August in both years covered by the baseline surveys, apportioned and availability bias-corrected mean guillemot abundances dropped substantially, with low abundances observed in both August 2021 and August 2022. These temporal patterns are indicative of a rapid arrival and departure of birds from Caledonia South Survey Area close to the start and end of the breeding season. The higher mean abundances in May to July indicate that Caledonia South Survey Area is likely being used by breeding adults from nearby colonies. Apportioned and availability bias-corrected mean guillemot abundances across the breeding seasons of both 2021 and 2022 were relatively similar, with no obvious significant differences in apportioned and availability bias-corrected mean guillemot abundances between the two seasons.

Reductions in mean apportioned and availability bias-corrected abundance in the breeding season surveys outside the peak survey month varied from 4% to 95%, with most surveys falling somewhere in the middle of the two extremes of this range. This indicates that the mean apportioned abundances were highly variable throughout the breeding season surveys when compared with the peak mean apportioned abundance for this season during the baseline survey period.

During both years of surveys, guillemots were also recorded during the non-breeding period (September to March) in considerably lower numbers than during the breeding season. The wintering peak of abundance occurred in September 2022 (Table 67, Figure 22):

- 341 individuals were recorded in Caledonia South, resulting in an unapportioned mean abundance estimate of 1,988 [1,084; 3,142], an apportioned mean abundance estimate of 2,282 [1,199; 3,515] and an apportioned and availability bias-corrected mean abundance estimate of 2,980 [1,567; 4,585] individuals. These equated to a mean density estimate of 9.45 (unapportioned), 10.85 (apportioned) and 14.16 (apportioned and availability bias-corrected) birds/km$^2$.
- 1,247 individuals were recorded in Caledonia South plus 2 km buffer, resulting in an unapportioned mean abundance estimate of 7,123 [1,868; 15,834], an apportioned mean abundance estimate of 8,150 [2,832; 17,259] and an apportioned and availability bias-corrected mean abundance estimate of 10,674 [3,709; 22,604] individuals. These equated to mean density estimates of 19.82 (unapportioned), 22.66 (apportioned) and 29.67 (apportioned and availability bias-corrected) birds/km$^2$.
- 1,982 individuals were recorded in Caledonia South Survey Area, resulting in an unapportioned mean abundance estimate of 11,565 [4,044; 22,092], an apportioned mean abundance estimate of 12,918 [4,500; 24,544] and an apportioned and availability bias-corrected mean abundance estimate of 16,924 [5,897; 32,156] individuals. These equated to mean density estimates of 21.68 (unapportioned), 24.20 (apportioned) and 31.71 (apportioned and availability bias-corrected) birds/km$^2$.

During the breeding site attendance period (February and March), guillemots were also recorded in low numbers (lower than other periods of the non-breeding season), with peak numbers in March 2023 (Table 67, Figure 22):

- 157 individuals were recorded in Caledonia South in March 2023, resulting in an unapportioned mean abundance estimate of 910 [499; 1,461], an apportioned mean abundance estimate of 954 [531; 1,568] and an apportioned and availability bias-corrected mean abundance estimate of 1,231 [693; 2,011] individuals. These equated to mean density estimates of 4.33 (unapportioned), 4.53 (apportioned) and 5.85 (apportioned and availability bias-corrected) birds/km$^2$.
- 239 individuals were recorded in Caledonia South plus 2 km buffer in March 2023, resulting in an unapportioned mean abundance estimate of 1,376 [916; 2,021], an apportioned mean abundance estimate of 1,497 [1,007; 2,246] and an apportioned and availability bias-corrected mean abundance estimate of 1,933 [1,312; 2,881] individuals. These equated to mean density estimates of 3.83 (unapportioned), 4.16 (apportioned) and 5.37 (apportioned and availability bias-corrected) birds/km$^2$.
- 357 individuals were recorded in Caledonia South Survey Area in March 2023, resulting in an unapportioned mean abundance estimate of 2,080 [1,434; 2,832], an apportioned mean abundance estimate of 2,251 [1,494; 3,151] and an apportioned and availability bias-corrected mean abundance estimate of 2,899 [1,940; 4,043] individuals. These equated to mean density estimates of 3.90 (unapportioned), 4.22 (apportioned) and 5.43 (apportioned and availability bias-corrected) birds/km$^2$.

During the two non-breeding seasons covered by the baseline surveys, peak mean apportioned and availability bias-corrected guillemot abundances within Caledonia South Survey Area occurred in September, with surveys in other non-breeding season months recording considerably lower equivalent abundances than the overall peak for the two years of surveys, in September 2022. The timing of the non-breeding season peak indicates that post-breeding aggregations of birds, likely from multiple colonies across the wider area, may occur in Caledonia South Survey Area. Peak mean apportioned and availability bias-corrected guillemot abundances were generally low across

Caledonia South Survey Area during the winter months, with mean abundances increasing from February in both survey years included in the baseline survey period. This indicates that birds attending nearby breeding colonies prior to the breeding season may be using Caledonia South Survey Area.

Reductions in mean apportioned and availability bias-corrected abundance relative to the peak for the non-breeding season were between 55% to 99%, with most surveys reporting reductions closer to the upper limit of the range. This indicates that the mean apportioned guillemot abundances were somewhat variable throughout the non-breeding season surveys when compared with the peak mean apportioned abundance for the baseline survey period, with many of the surveys recording mean abundances for this species that were considerably lower than the peak mean apportioned abundance for this seasonal period.

Good measures of precisions were calculated for most survey months (CV ≤ 0.16; Table 67). Within Caledonia South, 18 surveys out of 24 had precision values of CV ≤ 0.16, and most surveys during the breeding season (nine of ten) had CV values of ≤ 0.16. CV values during the non-breeding season were higher (more often in the region of 0.2 to 0.5), indicating lower levels of precision when compared with breeding season surveys (Table 67). For Caledonia South plus buffer regions, CV values were generally lower than the corresponding CV values for Caledonia South, indicating higher precision within these reporting regions (Table 67).

**Table 67** **Raw counts, unapportioned, apportioned and apportioned and availability bias-corrected abundance and density estimates (birds per km$^2$) of guillemots in Caledonia South, Caledonia South plus 2 km buffer and Caledonia South Survey Area during the May 2021 to April 2023 survey period. Colour gradients follow the ascending order of guillemot raw counts per season, with light yellow to orange (peak number) for the breeding season months (April to mid-August) and light blue to royal blue (peak number) for the wintering months (September to March). No colours were attributed to the breeding site attendance period (February to March)**

| Survey | Raw count | Total unapportioned | | | | | Total apportioned | | | | Total apportioned and bias-corrected | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Abundance | LCL | UCL | Precision (CV) | Density (km$^2$) | Abundance | LCL | UCL | Density (km$^2$) | Abundance | LCL | UCL | Density (km$^2$) |
| **a) Caledonia South** | | | | | | | | | | | | | | |
| **May-21** | 577 | 3,359 | 2,230 | 4,424 | 0.04 | 15.97 | 3,590 | 2,254 | 5,109 | 17.06 | 4,672 | 2,949 | 6,614 | 22.2 |
| **Jun-21** | 312 | 1,815 | 1,111 | 2,809 | 0.06 | 8.63 | 2,280 | 1,211 | 3,800 | 10.83 | 2,873 | 1,545 | 4,770 | 13.65 |
| **Jul-21** | **947** | **5,554** | **1,771** | **11,735** | **0.03** | **26.41** | **5,748** | **1,733** | **12,403** | **27.31** | **7,457** | **2,224** | **16,152** | **35.43** |
| **Aug-21** | 34 | 196 | 115 | 283 | 0.17 | 0.93 | 466 | 187 | 853 | 2.21 | 605 | 244 | 1,106 | 2.87 |
| **Sep-21** | 131 | 760 | 429 | 1,131 | 0.09 | 3.61 | 1,015 | 589 | 1,472 | 4.82 | 1,328 | 772 | 1,924 | 6.31 |
| **Oct-21** | 77 | 451 | 322 | 597 | 0.11 | 2.14 | 570 | 358 | 846 | 2.71 | 740 | 468 | 1,087 | 3.52 |
| **Nov-21** | 96 | 553 | 409 | 691 | 0.10 | 2.63 | 617 | 433 | 830 | 2.93 | 796 | 565 | 1,058 | 3.78 |
| **Dec-21** | 4 | 23 | 6 | 41 | 0.50 | 0.11 | 202 | 119 | 292 | 0.96 | 265 | 156 | 383 | 1.26 |
| **Jan-22** | 36 | 208 | 75 | 364 | 0.17 | 0.99 | 277 | 102 | 462 | 1.32 | 364 | 134 | 606 | 1.73 |
| **Feb-22** | 39 | 211 | 97 | 336 | 0.16 | 1.00 | 444 | 262 | 679 | 2.11 | 581 | 343 | 885 | 2.76 |
| **Mar-22** | 55 | 295 | 140 | 510 | 0.13 | 1.40 | 390 | 137 | 691 | 1.85 | 433 | 154 | 759 | 2.06 |
| **Apr-22** | 88 | 507 | 219 | 956 | 0.11 | 2.41 | 595 | 250 | 1,081 | 2.83 | 719 | 316 | 1,268 | 3.41 |
| **May-22** | 664 | 3,834 | 2,483 | 5,336 | 0.04 | 18.23 | 4,248 | 2,652 | 6,001 | 20.19 | 5,561 | 3,475 | 7,851 | 26.42 |
| **Jun-22** | 732 | 4,239 | 2,236 | 6,284 | 0.04 | 20.16 | 4,364 | 2,263 | 6,534 | 20.74 | 5,671 | 2,942 | 8,486 | 26.95 |
| **Jul-22** | 622 | 3,628 | 1,972 | 5,489 | 0.04 | 17.25 | 3,950 | 1,903 | 6,321 | 18.77 | 5,028 | 2,406 | 8,058 | 23.89 |
| **Aug-22** | 45 | 259 | 81 | 483 | 0.15 | 1.23 | 294 | 92 | 545 | 1.40 | 383 | 121 | 710 | 1.82 |
| **Sep-22** | **341** | **1,988** | **1,084** | **3,142** | **0.05** | **9.45** | **2,282** | **1,199** | **3,515** | **10.85** | **2,980** | **1,567** | **4,585** | **14.16** |
| **Oct-22** | 25 | 147 | 65 | 241 | 0.20 | 0.70 | 318 | 82 | 787 | 1.51 | 358 | 97 | 865 | 1.7 |
| **Nov-22** | 1 | 6 | 1 | 18 | 1.00 | 0.03 | 22 | 4 | 54 | 0.10 | 28 | 5 | 71 | 0.13 |
| **Dec-22** | 21 | 124 | 59 | 206 | 0.22 | 0.59 | 160 | 77 | 264 | 0.76 | 210 | 101 | 346 | 1 |
| **Jan-23** | 42 | 246 | 140 | 386 | 0.15 | 1.17 | 257 | 125 | 406 | 1.22 | 324 | 162 | 505 | 1.54 |
| **Feb-23** | 126 | 719 | 405 | 1,125 | 0.09 | 3.42 | 789 | 331 | 1,398 | 3.75 | 910 | 378 | 1,630 | 4.32 |
| **Mar-23** | 157 | 910 | 499 | 1,461 | 0.08 | 4.33 | 954 | 531 | 1,568 | 4.53 | 1,231 | 693 | 2,011 | 5.85 |
| **Apr-23** | 291 | 1,655 | 700 | 3,242 | 0.06 | 7.87 | 1,734 | 481 | 3,746 | 8.24 | 2,165 | 602 | 4,688 | 10.29 |
| **b) Caledonia South plus 2 km buffer** | | | | | | | | | | | | | | |
| **May-21** | 1,199 | 6,928 | 4,923 | 8,864 | 0.03 | 19.27 | 7,460 | 5,259 | 10,218 | 20.74 | 9,720 | 6,870 | 13,283 | 27.02 |

| Survey | Raw count | Total unapportioned | | | | | Total apportioned | | | | Total apportioned and bias-corrected | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Abundance | LCL | UCL | Precision (CV) | Density (km$^2$) | Abundance | LCL | UCL | Density (km$^2$) | Abundance | LCL | UCL | Density (km$^2$) |
| **Jun-21** | 560 | 3,248 | 2,169 | 4,912 | 0.04 | 9.04 | 4,397 | 3,063 | 7,061 | 12.22 | 5,537 | 3,869 | 8,917 | 15.39 |
| **Jul-21** | **1,563** | **9,094** | **2,868** | **19,305** | **0.03** | **25.30** | **9,525** | **3,142** | **20,132** | **26.48** | **12,351** | **4,037** | **26,194** | **34.33** |
| **Aug-21** | 48 | 275 | 183 | 378 | 0.14 | 0.77 | 846 | 726 | 1,516 | 2.35 | 1,099 | 950 | 1,964 | 3.06 |
| **Sep-21** | 455 | 2,629 | 1,202 | 4,704 | 0.05 | 7.31 | 3,081 | 1,661 | 5,312 | 8.56 | 4,034 | 2,176 | 6,952 | 11.21 |
| **Oct-21** | 143 | 829 | 615 | 1,027 | 0.08 | 2.31 | 1,092 | 855 | 1,544 | 3.04 | 1,403 | 1,105 | 1,960 | 3.9 |
| **Nov-21** | 202 | 1,156 | 916 | 1,385 | 0.07 | 3.22 | 1,237 | 968 | 1,574 | 3.44 | 1,598 | 1,258 | 2,021 | 4.44 |
| **Dec-21** | 11 | 63 | 29 | 109 | 0.30 | 0.18 | 418 | 384 | 591 | 1.16 | 549 | 504 | 775 | 1.52 |
| **Jan-22** | 51 | 293 | 126 | 466 | 0.14 | 0.82 | 391 | 224 | 617 | 1.09 | 512 | 293 | 808 | 1.42 |
| **Feb-22** | 78 | 417 | 224 | 673 | 0.11 | 1.16 | 794 | 574 | 1,225 | 2.21 | 1,033 | 751 | 1,585 | 2.87 |
| **Mar-22** | 73 | 386 | 217 | 630 | 0.12 | 1.07 | 532 | 289 | 901 | 1.48 | 606 | 341 | 1,013 | 1.68 |
| **Apr-22** | 210 | 1,201 | 801 | 1,658 | 0.07 | 3.34 | 1,335 | 735 | 2,084 | 3.71 | 1,537 | 864 | 2,390 | 4.27 |
| **May-22** | 964 | 5,530 | 3,700 | 7,446 | 0.03 | 15.38 | 6,066 | 4,161 | 8,569 | 16.86 | 7,942 | 5,452 | 11,216 | 22.08 |
| **Jun-22** | 1,221 | 6,932 | 4,349 | 9,560 | 0.03 | 19.29 | 7,112 | 4,523 | 10,004 | 19.77 | 9,237 | 5,877 | 12,981 | 25.68 |
| **Jul-22** | 1,149 | 6,648 | 3,709 | 10,449 | 0.03 | 18.50 | 7,335 | 4,123 | 11,596 | 20.39 | 9,395 | 5,272 | 14,864 | 26.12 |
| **Aug-22** | 98 | 560 | 377 | 794 | 0.10 | 1.56 | 622 | 440 | 936 | 1.73 | 811 | 574 | 1,217 | 2.25 |
| **Sep-22** | **1,247** | **7,123** | **1,868** | **15,834** | **0.03** | **19.82** | **8,150** | **2,832** | **17,259** | **22.66** | **10,674** | **3,709** | **22,604** | **29.67** |
| **Oct-22** | 64 | 369 | 109 | 760 | 0.13 | 1.03 | 692 | 410 | 1,503 | 1.92 | 799 | 439 | 1,745 | 2.22 |
| **Nov-22** | 3 | 17 | 3 | 35 | 0.58 | 0.05 | 38 | 24 | 77 | 0.11 | 50 | 31 | 101 | 0.14 |
| **Dec-22** | 39 | 225 | 144 | 317 | 0.16 | 0.63 | 273 | 192 | 380 | 0.76 | 358 | 252 | 499 | 1 |
| **Jan-23** | 80 | 459 | 333 | 620 | 0.11 | 1.28 | 474 | 290 | 729 | 1.32 | 588 | 368 | 888 | 1.63 |
| **Feb-23** | 226 | 1,290 | 839 | 1,746 | 0.07 | 3.59 | 1,385 | 768 | 2,189 | 3.85 | 1,612 | 885 | 2,554 | 4.48 |
| **Mar-23** | 239 | 1,376 | 916 | 2,021 | 0.06 | 3.83 | 1,497 | 1,007 | 2,246 | 4.16 | 1,933 | 1,312 | 2,881 | 5.37 |
| **Apr-23** | 382 | 2,140 | 986 | 3,870 | 0.05 | 5.95 | 2,240 | 946 | 4,330 | 6.23 | 2,804 | 1,192 | 5,418 | 7.8 |
| **c) Caledonia South Survey Area** | | | | | | | | | | | | | | |
| **May-21** | 1,602 | 9,295 | 6,353 | 12,091 | 0.02 | 17.43 | 10,018 | 6,512 | 13,810 | 18.77 | 13,014 | 8,492 | 17,894 | 24.38 |
| **Jun-21** | 825 | 4,795 | 3,022 | 6,858 | 0.03 | 8.99 | 6,640 | 3,386 | 10,826 | 12.44 | 8,271 | 4,239 | 13,398 | 15.5 |
| **Jul-21** | 2,175 | 13,061 | 4,966 | 24,453 | 0.02 | 24.49 | 13,623 | 4,566 | 25,544 | 25.52 | 17,676 | 5,884 | 33,226 | 33.12 |
| **Aug-21** | 93 | 535 | 391 | 702 | 0.10 | 1.00 | 2,376 | 981 | 3,829 | 4.45 | 3,094 | 1,281 | 4,981 | 5.8 |
| **Sep-21** | 758 | 4,402 | 2,038 | 7,247 | 0.04 | 8.25 | 5,163 | 2,549 | 8,681 | 9.67 | 6,762 | 3,341 | 11,366 | 12.67 |
| **Oct-21** | 240 | 1,393 | 1,004 | 1,805 | 0.06 | 2.61 | 1,852 | 1,142 | 2,686 | 3.47 | 2,374 | 1,487 | 3,393 | 4.45 |
| **Nov-21** | 329 | 1,892 | 1,420 | 2,426 | 0.06 | 3.55 | 2,046 | 1,404 | 2,743 | 3.83 | 2,654 | 1,829 | 3,546 | 4.97 |
| **Dec-21** | 14 | 81 | 35 | 145 | 0.27 | 0.15 | 720 | 513 | 956 | 1.35 | 944 | 673 | 1,253 | 1.77 |

| Survey | Raw count | Total unapportioned | | | | | Total apportioned | | | | Total apportioned and bias-corrected | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Abundance | LCL | UCL | Precision (CV) | Density ($km^2$) | Abundance | LCL | UCL | Density ($km^2$) | Abundance | LCL | UCL | Density ($km^2$) |
| **Jan-22** | 67 | 386 | 190 | 570 | 0.12 | 0.72 | 519 | 269 | 813 | 0.97 | 676 | 352 | 1,055 | 1.27 |
| **Feb-22** | 117 | 635 | 380 | 961 | 0.09 | 1.19 | 1,162 | 703 | 1,712 | 2.18 | 1,512 | 920 | 2,217 | 2.83 |
| **Mar-22** | 113 | 607 | 381 | 913 | 0.09 | 1.14 | 803 | 395 | 1,263 | 1.50 | 932 | 464 | 1,457 | 1.75 |
| **Apr-22** | 375 | 2,150 | 1,347 | 3,044 | 0.05 | 4.03 | 2,331 | 1,277 | 3,489 | 4.37 | 2,618 | 1,426 | 3,926 | 4.9 |
| **May-22** | 1,508 | 8,667 | 5,972 | 10,989 | 0.03 | 16.25 | 9,500 | 6,322 | 12,302 | 17.80 | 12,401 | 8,267 | 16,033 | 23.23 |
| **Jun-22** | 1,563 | 9,051 | 5,687 | 12,682 | 0.03 | 16.97 | 9,310 | 5,396 | 12,860 | 17.44 | 12,061 | 6,979 | 16,661 | 22.6 |
| **Jul-22** | **2,278** | **13,189** | **6,924** | **20,611** | **0.02** | **24.73** | **14,246** | **6,710** | **23,854** | **26.69** | **18,392** | **8,622** | **30,838** | **34.46** |
| **Aug-22** | 140 | 803 | 504 | 1,129 | 0.08 | 1.51 | 910 | 516 | 1,335 | 1.71 | 1,189 | 676 | 1,740 | 2.23 |
| **Sep-22** | **1,982** | **11,565** | **4,044** | **22,092** | **0.02** | **21.68** | **12,918** | **4,500** | **24,544** | **24.20** | **16,924** | **5,897** | **32,156** | **31.71** |
| **Oct-22** | 96 | 564 | 170 | 1,169 | 0.10 | 1.06 | 911 | 194 | 1,971 | 1.71 | 1,084 | 236 | 2,341 | 2.03 |
| **Nov-22** | 12 | 70 | 18 | 129 | 0.29 | 0.13 | 151 | 57 | 299 | 0.28 | 193 | 74 | 378 | 0.36 |
| **Dec-22** | 53 | 312 | 200 | 418 | 0.14 | 0.58 | 372 | 244 | 504 | 0.70 | 487 | 319 | 660 | 0.91 |
| **Jan-23** | 114 | 667 | 450 | 901 | 0.09 | 1.25 | 689 | 408 | 1,041 | 1.29 | 865 | 523 | 1,287 | 1.62 |
| **Feb-23** | 331 | 1,910 | 1,102 | 2,833 | 0.05 | 3.58 | 2,052 | 933 | 3,295 | 3.84 | 2,358 | 1,081 | 3,781 | 4.42 |
| **Mar-23** | 357 | 2,080 | 1,434 | 2,832 | 0.05 | 3.90 | 2,251 | 1,494 | 3,151 | 4.22 | 2,899 | 1,940 | 4,043 | 5.43 |
| **Apr-23** | 437 | 2,502 | 1,254 | 4,448 | 0.05 | 4.69 | 2,622 | 1,141 | 4,962 | 4.91 | 3,277 | 1,437 | 6,198 | 6.14 |

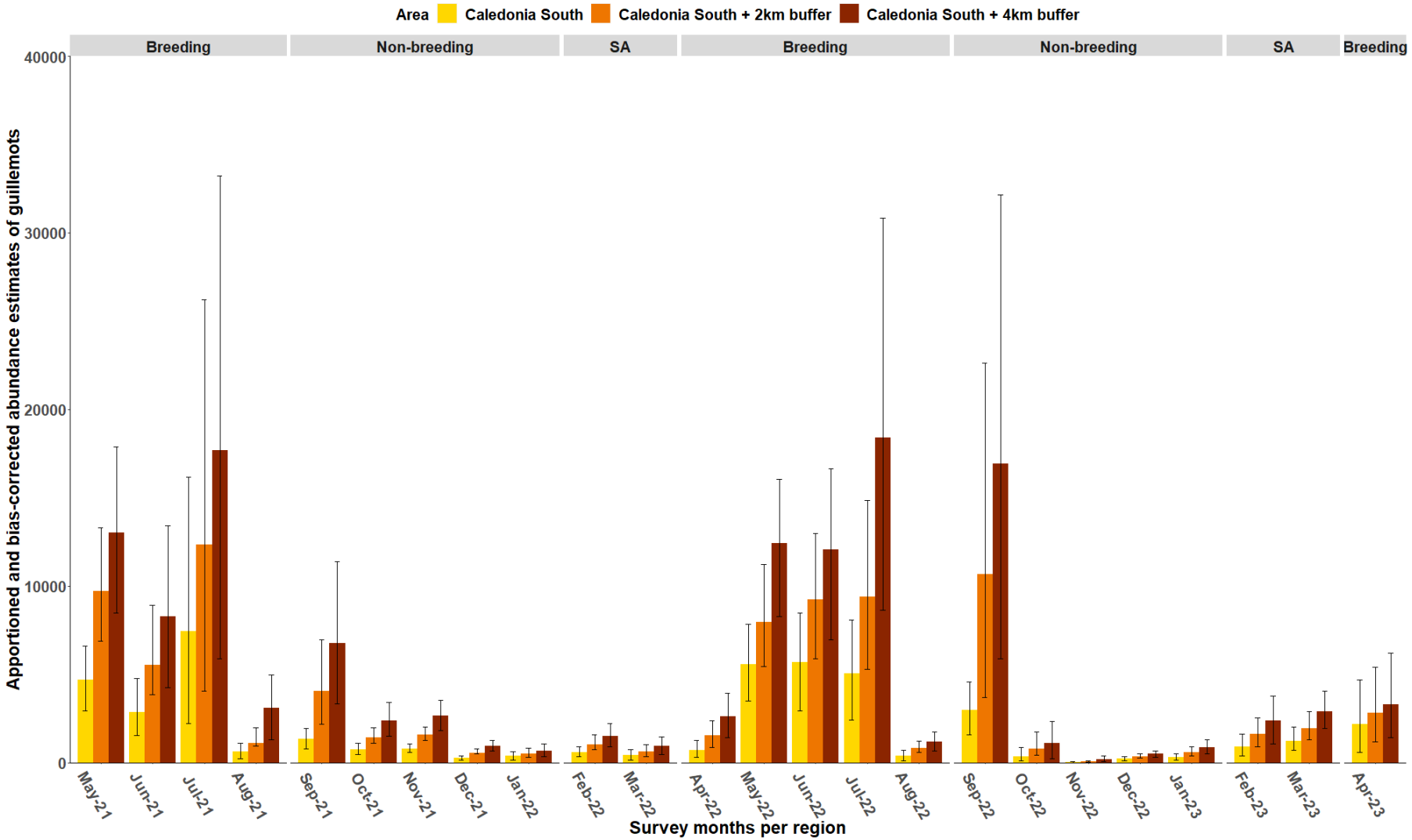



**Figure 22 Bar plot of the monthly apportioned and availability bias-corrected abundance estimates (with 95% confidence intervals) of total guillemots recorded in each reporting region of Caledonia South Survey Area, during the May 2021 to April 2023 survey period. Guillemot seasonal periods are also displayed. SA stands for breeding site attendance**

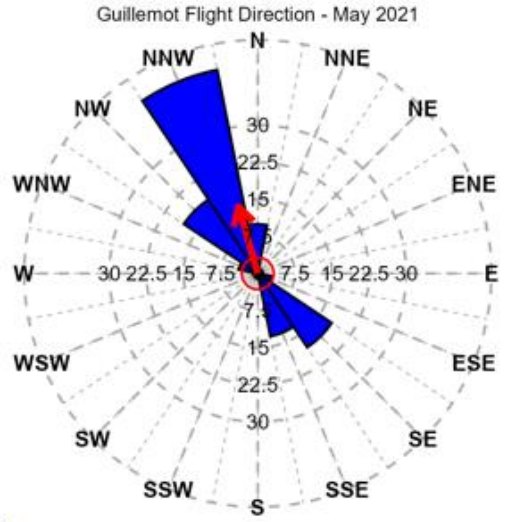
### *ii. Distribution and behaviour*

Maps of distribution are shown in Appendix 4: Figures A4.103-126. In May to July 2021, November 2021, April to July 2022, December 2022, and in January and March 2023, guillemots were distributed throughout the Survey Area without any discernible distributional pattern (Figure A4.103-105, 109, 114-117, 122-123, 125). In August and October 2021, and January 2022, largest concentrations of guillemots occurred in the east to south of the Survey Area (Figure A4.106, 108, 111). In September 2021, February, March and August to November 2022, February and April 2023, most birds were located towards the south of the Survey Area (Figure A4.107, 112-113, 118-121, 124, 126). Higher numbers of birds to the south (and sometimes in the northwest) of the Survey Area may be linked to the proximity of these areas to breeding colonies (East Caithness Cliffs SPA to the west of the Survey Area, and Troup, Pennan and Lion's Heads SPA to the south of the Survey Area).

Significant predominant direction of flight was recorded in:

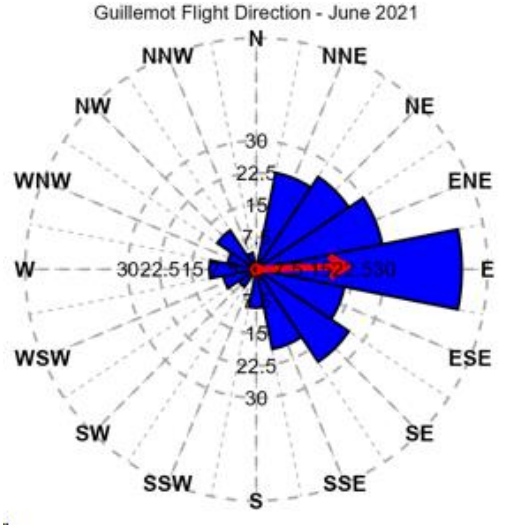
- **May**
  - 2021 north-northwest (Figure 23a)
- **June**
  - 2021 east (Figure 23b)
  - 2022 southeast (Figure 23e)
- **July**
  - 2022 southeast (Figure 23f)
- **October**
  - 2022 south-southeast (Figure 23g)
- **February**
  - 2023 northwest (Figure 23h)
- **March**
  - 2022 west-northwest (Figure 23c)
- **April**
  - 2022 northwest (Figure 23d)

As very few birds were recorded in flight in other surveys, and January, March and April 2023, they were too infrequent to determine any preference in flight direction (Appendix 5, Figure A5.17).




| | |
|---|---|
| Number of Observations | 114 |
| Mean Vector (μ) | 344.331 |
| Length of Mean Vector (r) | 0.334 |
| Rayleigh Test (Z) | 12.752 |
| Rayleigh Test (p) | 0.001 |

**a May 2021**



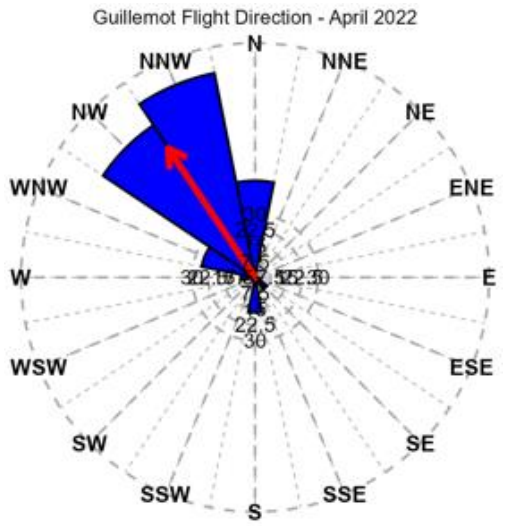

| | |
|---|---|
| Number of Observations | 250 |
| Mean Vector (μ) | 88.667 |
| Length of Mean Vector (r) | 0.443 |
| Rayleigh Test (Z) | 48.993 |
| Rayleigh Test (p) | <0.001 |

**b June 2021**



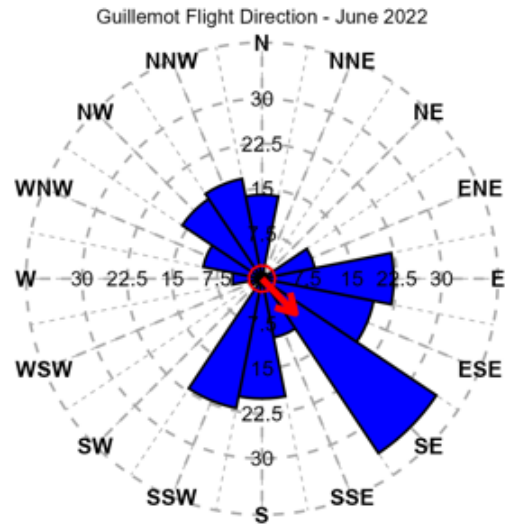

| | |
|---|---|
| Number of Observations | 76 |
| Mean Vector (μ) | 301.781 |
| Length of Mean Vector (r) | 0.777 |
| Rayleigh Test (Z) | 45.871 |
| Rayleigh Test (p) | <0.001 |

**c March 2022**



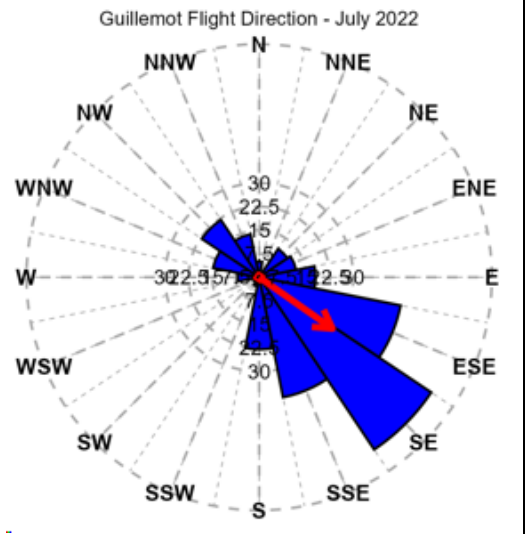

| | |
|---|---|
| Number of Observations | 296 |
| Mean Vector (μ) | 326.710 |
| Length of Mean Vector (r) | 0.747 |
| Rayleigh Test (Z) | 165.019 |
| Rayleigh Test (p) | <0.001 |

**d April 2022**



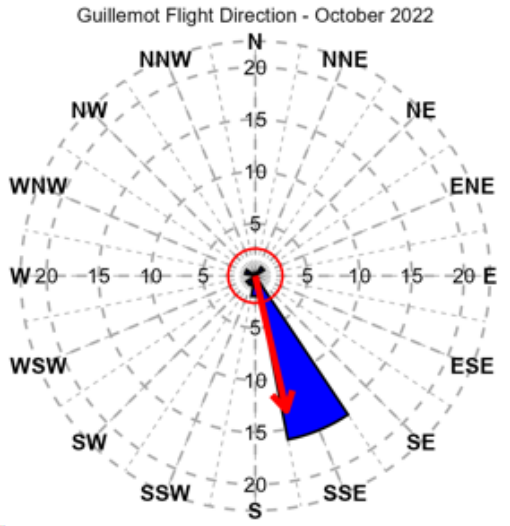

| | |
|---|---|
| Number of Observations | 204 |
| Mean Vector (μ) | 136.358 |
| Length of Mean Vector (r) | 0.229 |
| Rayleigh Test (Z) | 10.691 |
| Rayleigh Test (p) | <0.001 |

**e June 2022**



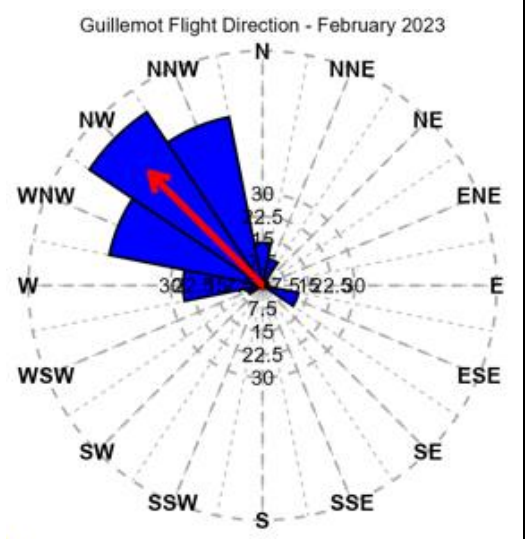

| | |
|---|---|
| Number of Observations | 285 |
| Mean Vector (μ) | 125.997 |
| Length of Mean Vector (r) | 0.432 |
| Rayleigh Test (Z) | 53.283 |
| Rayleigh Test (p) | <0.001 |

**f July 2022**




| | |
|---|---|
| Number of Observations | 22 |
| Mean Vector (μ) | 167.081 |
| Length of Mean Vector (r) | 0.828 |
| Rayleigh Test (Z) | 15.072 |
| Rayleigh Test (p) | <0.001 |

**g October 2022**




| | |
|---|---|
| Number of Observations | 247 |
| Mean Vector (μ) | 315.856 |
| Length of Mean Vector (r) | 0.764 |
| Rayleigh Test (Z) | 144.290 |
| Rayleigh Test (p) | <0.001 |

**h February 2023**

**Figure 23 Summary of flight direction of guillemots within surveys where a significant flight direction was recorded during the May 2021 to April 2023 survey period**

## 4.19 Razorbill

### *i. Abundance and density estimates*

#### *Caledonia OWF*

A total of 2,542 razorbills were recorded in the Survey Area during both years of baseline surveys (Table 8). Razorbills were recorded in every survey apart from November 2021 (Table 8, Table 68, Figure 24). In contrast to guillemot, highest abundances of razorbills were recorded during the non-breeding period (September to February). Peak abundances were recorded in September 2022 (Table 68, Figure 24):

- 250 individuals were recorded in Caledonia OWF, resulting in an unapportioned mean abundance estimate of 1,447 [619; 2,361], an apportioned mean abundance estimate of 1,731 [805; 2,821] and an apportioned and availability bias-corrected mean abundance estimate of 2,093 [974; 3,408] individuals. These equated to mean density estimates of 3.39 (unapportioned), 4.05 (apportioned) and 4.90 (apportioned and availability bias-corrected) birds/km$^2$.
- 401 individuals were recorded in Caledonia OWF plus 2 km buffer, resulting in an unapportioned mean abundance estimate of 2,314 [1,437; 3,342], an apportioned mean abundance estimate of 2,682 [1,707; 3,857] and an apportioned and availability bias-corrected mean abundance estimate of 3,232 [2,065; 4,636] individuals. These equated to mean density estimates of 3.60 (unapportioned), 4.16 (apportioned) and 5.02 (apportioned and availability bias-corrected) birds/km$^2$.
- 514 individuals were recorded in the Survey Area, resulting in an unapportioned mean abundance estimate of 2,999 [1,844; 4,231], an apportioned mean abundance estimate of 3,395 [2,092; 4,797] and an apportioned and availability bias-corrected mean abundance estimate of 4,094 [2,531; 5,772] individuals. These equated to mean density estimates of 3.39 (unapportioned), 3.84 (apportioned) and 4.63 (apportioned and availability bias-corrected) birds/km$^2$.

During the breeding site attendance period (March), razorbills were recorded in low numbers (considerably lower than the rest of the non-breeding season), with a peak abundance for the survey period recorded in March 2023: (Table 65; Figure 20):

- 48 individuals were recorded in Caledonia OWF, resulting in an unapportioned mean abundance estimate of 280 [169; 379], an apportioned mean abundance estimate of 302 [166; 440] and an apportioned and availability bias-corrected mean abundance estimate of 360 [200; 521] individuals. These equated to mean density estimates of 0.66 (unapportioned), 0.71 (apportioned) and 0.84 (apportioned and availability bias-corrected) birds/km$^2$.
- 58 individuals were recorded in Caledonia OWF plus 2 km buffer, resulting in an unapportioned mean abundance estimate of 336 [191; 504], an apportioned mean abundance estimate of 366 [183; 590] and an apportioned and availability bias-corrected mean abundance estimate of 432 [220; 690] individuals. These equated to mean density estimates of 0.52 (unapportioned), 0.57 (apportioned) and 0.67 (apportioned and availability bias-corrected) birds/km$^2$.
- 84 individuals were recorded in the Survey Area, resulting in an unapportioned mean abundance estimate of 493 [323; 646], an apportioned mean abundance estimate of 537 [307; 785] and an apportioned and availability bias-corrected mean abundance estimate of 634 [368; 919] individuals. These equated to mean density estimates of 0.56 (unapportioned), 0.61 (apportioned) and 0.72 (apportioned and availability bias-corrected) birds/km$^2$.

During the two non-breeding seasons covered by the baseline surveys, peak mean apportioned and availability bias-corrected abundances within the Survey Area occurred in September and February/March. The largest overall peak was in September 2022, when mean apportioned and availability bias-corrected abundances were considerably larger than in any other survey during the non-breeding season for this species. During the winter months, relatively low mean apportioned and availability bias-corrected abundances occurred in both non-breeding seasons, with slightly higher abundances recorded in February 2022, February 2023 and March 2023. The timing of the non-breeding season peaks indicates that the Survey Area may be relatively important to post-breeding aggregations of birds (likely from a number of breeding colonies in the wider area), and birds attending colonies in the pre-breeding period.

Reductions in mean apportioned and availability bias-corrected abundance relative to the peak were between 80% to >99.5%, reflecting the fact that the September 2022 peak was very large relative to the other mean apportioned and availability bias-corrected abundances recorded for razorbill in the Survey Area and reporting regions during the non-breeding season.

During the breeding season (April to mid-August), peak mean abundance was recorded in May 2022 (Table 68, Figure 24):

- 207 individuals were recorded in Caledonia OWF, resulting in an unapportioned mean abundance estimate of 1,199 [591; 2,126], an apportioned mean abundance estimate of 1,323 [608; 2,417] and an apportioned and availability bias-corrected mean abundance estimate of 1,599 [735; 2,916] individuals. These equated to mean density estimates of 2.81 (unapportioned), 3.09 (apportioned) and 3.74 (apportioned and availability bias-corrected) birds/km$^2$.
- 290 individuals were recorded in Caledonia OWF plus 2 km buffer, resulting in an unapportioned mean abundance estimate of 1,659 [938; 2,626], an apportioned mean abundance estimate of 1,824 [1,002; 2,944] and an apportioned and availability bias-corrected mean abundance estimate of 2,205 [1,213; 3,355] individuals. These equated to mean density estimates of 2.58 (unapportioned), 2.83 (apportioned) and 3.42 (apportioned and availability bias-corrected) birds/km$^2$.
- 406 individuals were recorded in the Survey Area, resulting in an unapportioned mean abundance estimate of 2,357 [1,260; 3,664], an apportioned mean abundance estimate of 2,590 [1,418; 4,061] and an apportioned and availability bias-corrected mean abundance estimate of 3,133 [1,716; 4,907] individuals. These equated to mean density estimates of 2.67 (unapportioned), 2.93 (apportioned) and 3.54 (apportioned and availability bias-corrected) birds/km$^2$.

In both breeding seasons covered by the baseline surveys, apportioned and availability bias-corrected mean razorbill abundances across the Survey Area were slightly lower at the beginning of the season (i.e. April) than other months in the breeding season. During the 2021 breeding season, abundances between May and August 2021 were relatively consistent, with the peak apportioned and availability bias-corrected mean razorbill abundance occurring in July 2021. During the 2022 breeding season, a large peak in apportioned and availability bias-corrected mean razorbill abundances (which was the overall breeding season peak month) was recorded in May 2022. Abundances were very low in June 2022, and also low in August 2022, with a larger apportioned and availability bias-corrected mean abundance in July 2022 across the Survey Area. The reasons for the differences in temporal patterns between the 2021 and 2022 breeding seasons within the Survey Area are unclear.

Reductions in mean apportioned and availability bias-corrected abundance in the breeding season surveys outside the peak survey month varied from 28% to 92%, with most surveys falling somewhere in the middle of the two extremes of this range. This indicates that the mean apportioned abundances were somewhat variable throughout the breeding season surveys when compared with the peak mean apportioned abundance for this season during the baseline survey period.

Precision values were quite variable for this species throughout the survey period (Table 68). CV values of ≤ 0.16 were reported in nine of 23 baseline surveys across Caledonia OWF, with lower precision values (i.e. higher levels of precision) coinciding with surveys where higher numbers of razorbills were recorded (Table 68). For Caledonia OWF plus buffer regions, CV values were generally lower than the corresponding CV values for Caledonia OWF, indicating higher precision within these reporting regions (Table 68).

**Table 68** **Raw counts, unapportioned, apportioned, and apportioned and availability bias-corrected abundance and density estimates (birds per km$^2$) of razorbills in Caledonia OWF, Caledonia OWF plus 2 km buffer and the Survey Area during the May 2021 to April 2023 survey period. Colour gradients follow the ascending order of razorbill raw counts per season, with light yellow to orange (peak number) for the breeding season months (April to mid-August) and light blue to royal blue (peak number) for the wintering months (September to February). No colours were attributed to the breeding site attendance period (March)**

| Survey | Raw count | Total unapportioned | | | | | Total apportioned | | | | Total apportioned and bias-corrected | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Abundance | LCL | UCL | Precision (CV) | Density (km$^2$) | Abundance | LCL | UCL | Density (km$^2$) | Abundance | LCL | UCL | Density (km$^2$) |
| **a) Caledonia OWF** | | | | | | | | | | | | | | |
| **May-21** | 63 | 367 | 245 | 478 | 0.13 | 0.86 | 396 | 257 | 528 | 0.93 | 479 | 312 | 639 | 1.12 |
| **Jun-21** | 53 | 311 | 188 | 452 | 0.14 | 0.73 | 383 | 210 | 612 | 0.9 | 458 | 253 | 729 | 1.07 |
| **Jul-21** | 126 | 743 | 419 | 1,168 | 0.09 | 1.74 | 775 | 436 | 1,243 | 1.81 | 938 | 528 | 1,505 | 2.19 |
| **Aug-21** | 35 | 203 | 116 | 307 | 0.17 | 0.48 | 435 | 182 | 785 | 1.02 | 527 | 221 | 951 | 1.23 |
| **Sep-21** | 24 | 139 | 70 | 215 | 0.20 | 0.33 | 193 | 100 | 301 | 0.45 | 231 | 121 | 358 | 0.54 |
| **Oct-21** | 6 | 35 | 18 | 53 | 0.41 | 0.08 | 44 | 21 | 68 | 0.1 | 53 | 25 | 83 | 0.12 |
| **Dec-21** | 4 | 23 | 4 | 46 | 0.50 | 0.05 | 153 | 61 | 286 | 0.36 | 185 | 74 | 346 | 0.43 |
| **Jan-22** | 3 | 17 | 3 | 41 | 0.58 | 0.04 | 23 | 5 | 55 | 0.05 | 28 | 6 | 67 | 0.07 |
| **Feb-22** | 23 | 124 | 59 | 194 | 0.21 | 0.29 | 279 | 140 | 414 | 0.65 | 338 | 170 | 502 | 0.79 |
| **Mar-22** | 5 | 27 | 5 | 48 | 0.45 | 0.06 | 47 | 9 | 100 | 0.11 | 55 | 11 | 117 | 0.13 |
| **Apr-22** | 57 | 328 | 144 | 581 | 0.13 | 0.77 | 391 | 150 | 717 | 0.91 | 471 | 181 | 861 | 1.1 |
| **May-22** | 207 | 1,199 | 591 | 2,126 | 0.07 | 2.81 | 1,323 | 608 | 2,417 | 3.09 | 1,599 | 735 | 2,916 | 3.74 |
| **Jun-22** | 17 | 98 | 57 | 144 | 0.24 | 0.23 | 101 | 53 | 149 | 0.24 | 122 | 64 | 181 | 0.29 |
| **Jul-22** | 65 | 380 | 246 | 509 | 0.12 | 0.89 | 425 | 263 | 584 | 0.99 | 514 | 319 | 707 | 1.2 |
| **Aug-22** | 20 | 115 | 58 | 184 | 0.22 | 0.27 | 135 | 65 | 218 | 0.32 | 164 | 79 | 264 | 0.38 |
| **Sep-22** | 250 | 1,447 | 619 | 2,361 | 0.06 | 3.39 | 1,731 | 805 | 2,821 | 4.05 | 2,093 | 974 | 3,408 | 4.9 |
| **Oct-22** | 1 | 6 | 1 | 18 | <1 | 0.01 | 7 | 1 | 24 | 0.02 | 9 | 1 | 29 | 0.02 |
| **Nov-22** | 5 | 29 | 6 | 53 | 0.45 | 0.07 | 116 | 34 | 211 | 0.27 | 139 | 41 | 252 | 0.33 |
| **Dec-22** | 5 | 29 | 12 | 53 | 0.45 | 0.07 | 38 | 8 | 72 | 0.09 | 46 | 9 | 87 | 0.11 |
| **Jan-23** | 13 | 76 | 29 | 128 | 0.28 | 0.18 | 80 | 29 | 133 | 0.19 | 97 | 36 | 161 | 0.23 |
| **Feb-23** | 32 | 184 | 103 | 276 | 0.18 | 0.43 | 201 | 91 | 361 | 0.47 | 236 | 109 | 419 | 0.55 |
| **Mar-23** | 48 | 280 | 169 | 379 | 0.14 | 0.66 | 302 | 166 | 440 | 0.71 | 360 | 200 | 521 | 0.84 |
| **Apr-23** | 61 | 346 | 85 | 771 | 0.13 | 0.81 | 368 | 70 | 861 | 0.86 | 440 | 83 | 1,027 | 1.03 |
| **b) Caledonia OWF plus 2 km buffer** | | | | | | | | | | | | | | |
| **May-21** | 129 | 741 | 511 | 971 | 0.09 | 1.15 | 804 | 516 | 1,089 | 1.25 | 974 | 625 | 1,319 | 1.51 |
| **Jun-21** | 96 | 557 | 331 | 800 | 0.10 | 0.87 | 739 | 391 | 1,206 | 1.15 | 886 | 473 | 1,440 | 1.38 |

| Survey | Raw count | Total unapportioned | | | | | Total apportioned | | | | Total apportioned and bias-corrected | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Abundance | LCL | UCL | Precision (CV) | Density ($km^2$) | Abundance | LCL | UCL | Density ($km^2$) | Abundance | LCL | UCL | Density ($km^2$) |
| **Jul-21** | 195 | 1,130 | 620 | 1,894 | 0.07 | 1.76 | 1,187 | 661 | 1,909 | 1.84 | 1,437 | 800 | 2,312 | 2.23 |
| **Aug-21** | 51 | 291 | 171 | 405 | 0.14 | 0.45 | 760 | 359 | 1,313 | 1.18 | 921 | 435 | 1,590 | 1.43 |
| **Sep-21** | 53 | 304 | 195 | 431 | 0.14 | 0.47 | 372 | 239 | 510 | 0.58 | 449 | 289 | 612 | 0.7 |
| **Oct-21** | 8 | 46 | 23 | 69 | 0.35 | 0.07 | 60 | 28 | 93 | 0.09 | 72 | 34 | 112 | 0.11 |
| **Dec-21** | 6 | 34 | 11 | 57 | 0.41 | 0.05 | 259 | 135 | 351 | 0.4 | 314 | 163 | 425 | 0.49 |
| **Jan-22** | 7 | 40 | 11 | 69 | 0.38 | 0.06 | 52 | 14 | 92 | 0.08 | 63 | 17 | 112 | 0.1 |
| **Feb-22** | 44 | 236 | 155 | 306 | 0.15 | 0.37 | 518 | 393 | 623 | 0.8 | 627 | 476 | 754 | 0.97 |
| **Mar-22** | 8 | 42 | 21 | 64 | 0.35 | 0.07 | 77 | 33 | 131 | 0.12 | 93 | 39 | 155 | 0.14 |
| **Apr-22** | 95 | 539 | 261 | 941 | 0.10 | 0.84 | 645 | 281 | 1,126 | 1 | 774 | 340 | 1,349 | 1.2 |
| **May-22** | 290 | 1,659 | 938 | 2,626 | 0.06 | 2.58 | 1,824 | 1,002 | 2,944 | 2.83 | 2,205 | 1,213 | 3,555 | 3.42 |
| **Jun-22** | 24 | 138 | 86 | 183 | 0.20 | 0.21 | 142 | 94 | 189 | 0.22 | 172 | 113 | 229 | 0.27 |
| **Jul-22** | 140 | 806 | 553 | 1,088 | 0.08 | 1.25 | 905 | 568 | 1,261 | 1.41 | 1,094 | 687 | 1,521 | 1.7 |
| **Aug-22** | 55 | 315 | 200 | 440 | 0.13 | 0.49 | 366 | 221 | 551 | 0.57 | 444 | 268 | 667 | 0.69 |
| **Sep-22** | 401 | 2,314 | 1,437 | 3,342 | 0.05 | 3.6 | 2,682 | 1,707 | 3,857 | 4.16 | 3,232 | 2,065 | 4,636 | 5.02 |
| **Oct-22** | 7 | 41 | 7 | 111 | 0.38 | 0.06 | 45 | 7 | 128 | 0.07 | 54 | 9 | 155 | 0.08 |
| **Nov-22** | 10 | 58 | 17 | 110 | 0.32 | 0.09 | 159 | 52 | 295 | 0.25 | 191 | 63 | 354 | 0.3 |
| **Dec-22** | 13 | 76 | 35 | 123 | 0.28 | 0.12 | 94 | 33 | 166 | 0.15 | 114 | 40 | 201 | 0.18 |
| **Jan-23** | 17 | 99 | 46 | 169 | 0.24 | 0.15 | 104 | 47 | 176 | 0.16 | 126 | 56 | 213 | 0.19 |
| **Feb-23** | 46 | 263 | 149 | 383 | 0.15 | 0.41 | 283 | 133 | 463 | 0.44 | 334 | 160 | 542 | 0.52 |
| **Mar-23** | 58 | 336 | 191 | 504 | 0.13 | 0.52 | 366 | 183 | 590 | 0.57 | 432 | 220 | 690 | 0.67 |
| **Apr-23** | 82 | 465 | 125 | 924 | 0.11 | 0.72 | 501 | 130 | 1,032 | 0.78 | 600 | 156 | 1,233 | 0.93 |
| **c) Survey Area** | | | | | | | | | | | | | | |
| **May-21** | 178 | 1,040 | 666 | 1,432 | 0.07 | 1.18 | 1,132 | 731 | 1,585 | 1.28 | 1,371 | 885 | 1,920 | 1.55 |
| **Jun-21** | 160 | 941 | 553 | 1,471 | 0.08 | 1.06 | 1,303 | 630 | 2,191 | 1.47 | 1,563 | 761 | 2,621 | 1.77 |
| **Jul-21** | 296 | 1,787 | 1,238 | 2,481 | 0.06 | 2.02 | 1,873 | 1,266 | 2,593 | 2.12 | 2,265 | 1,533 | 3,133 | 2.56 |
| **Aug-21** | 61 | 354 | 186 | 528 | 0.13 | 0.4 | 1,358 | 494 | 2,491 | 1.54 | 1,644 | 598 | 3,016 | 1.86 |
| **Sep-21** | 80 | 468 | 298 | 661 | 0.11 | 0.53 | 566 | 350 | 810 | 0.64 | 684 | 424 | 974 | 0.77 |
| **Oct-21** | 10 | 59 | 35 | 82 | 0.32 | 0.07 | 74 | 42 | 106 | 0.08 | 90 | 50 | 129 | 0.1 |
| **Dec-21** | 6 | 35 | 12 | 64 | 0.41 | 0.04 | 326 | 165 | 465 | 0.37 | 395 | 200 | 563 | 0.45 |
| **Jan-22** | 8 | 46 | 17 | 81 | 0.35 | 0.05 | 60 | 31 | 99 | 0.07 | 73 | 37 | 120 | 0.08 |
| **Feb-22** | 59 | 324 | 247 | 406 | 0.13 | 0.37 | 683 | 536 | 806 | 0.77 | 827 | 649 | 977 | 0.94 |
| **Mar-22** | 13 | 70 | 32 | 108 | 0.28 | 0.08 | 122 | 50 | 211 | 0.14 | 147 | 61 | 252 | 0.17 |

| Survey | Raw count | Total unapportioned | | | | | Total apportioned | | | | Total apportioned and bias-corrected | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Abundance | LCL | UCL | Precision (CV) | Density ($km^2$) | Abundance | LCL | UCL | Density ($km^2$) | Abundance | LCL | UCL | Density ($km^2$) |
| **Apr-22** | 148 | 853 | 473 | 1,361 | 0.08 | 0.97 | 1,019 | 540 | 1,665 | 1.15 | 1,223 | 652 | 1,991 | 1.38 |
| **May-22** | **406** | **2,357** | **1,260** | **3,664** | **0.05** | **2.67** | **2,590** | **1,418** | **4,061** | **2.93** | **3,133** | **1,716** | **4,907** | **3.54** |
| **Jun-22** | 35 | 203 | 122 | 289 | 0.17 | 0.23 | 208 | 114 | 304 | 0.24 | 250 | 138 | 361 | 0.28 |
| **Jul-22** | 198 | 1,157 | 748 | 1,677 | 0.07 | 1.31 | 1,264 | 797 | 1,819 | 1.43 | 1,525 | 964 | 2,194 | 1.72 |
| **Aug-22** | 60 | 345 | 184 | 523 | 0.13 | 0.39 | 413 | 216 | 638 | 0.47 | 501 | 262 | 773 | 0.57 |
| **Sep-22** | **514** | **2,999** | **1,844** | **4,231** | **0.04** | **3.39** | **3,395** | **2,092** | **4,797** | **3.84** | **4,094** | **2,531** | **5,772** | **4.63** |
| **Oct-22** | 8 | 47 | 8 | 123 | 0.35 | 0.05 | 51 | 8 | 133 | 0.06 | 61 | 10 | 161 | 0.07 |
| **Nov-22** | 16 | 94 | 29 | 177 | 0.25 | 0.11 | 192 | 52 | 358 | 0.22 | 231 | 63 | 427 | 0.26 |
| **Dec-22** | 17 | 100 | 53 | 153 | 0.24 | 0.11 | 120 | 61 | 184 | 0.14 | 146 | 74 | 223 | 0.16 |
| **Jan-23** | 20 | 118 | 53 | 194 | 0.22 | 0.13 | 123 | 60 | 200 | 0.14 | 149 | 72 | 242 | 0.17 |
| **Feb-23** | 66 | 382 | 243 | 515 | 0.12 | 0.43 | 416 | 230 | 624 | 0.47 | 494 | 276 | 738 | 0.56 |
| **Mar-23** | 84 | 493 | 323 | 646 | 0.11 | 0.56 | 537 | 307 | 785 | 0.61 | 634 | 368 | 919 | 0.72 |
| **Apr-23** | 99 | 568 | 201 | 1,062 | 0.10 | 0.64 | 609 | 191 | 1,167 | 0.69 | 725 | 230 | 1,386 | 0.82 |

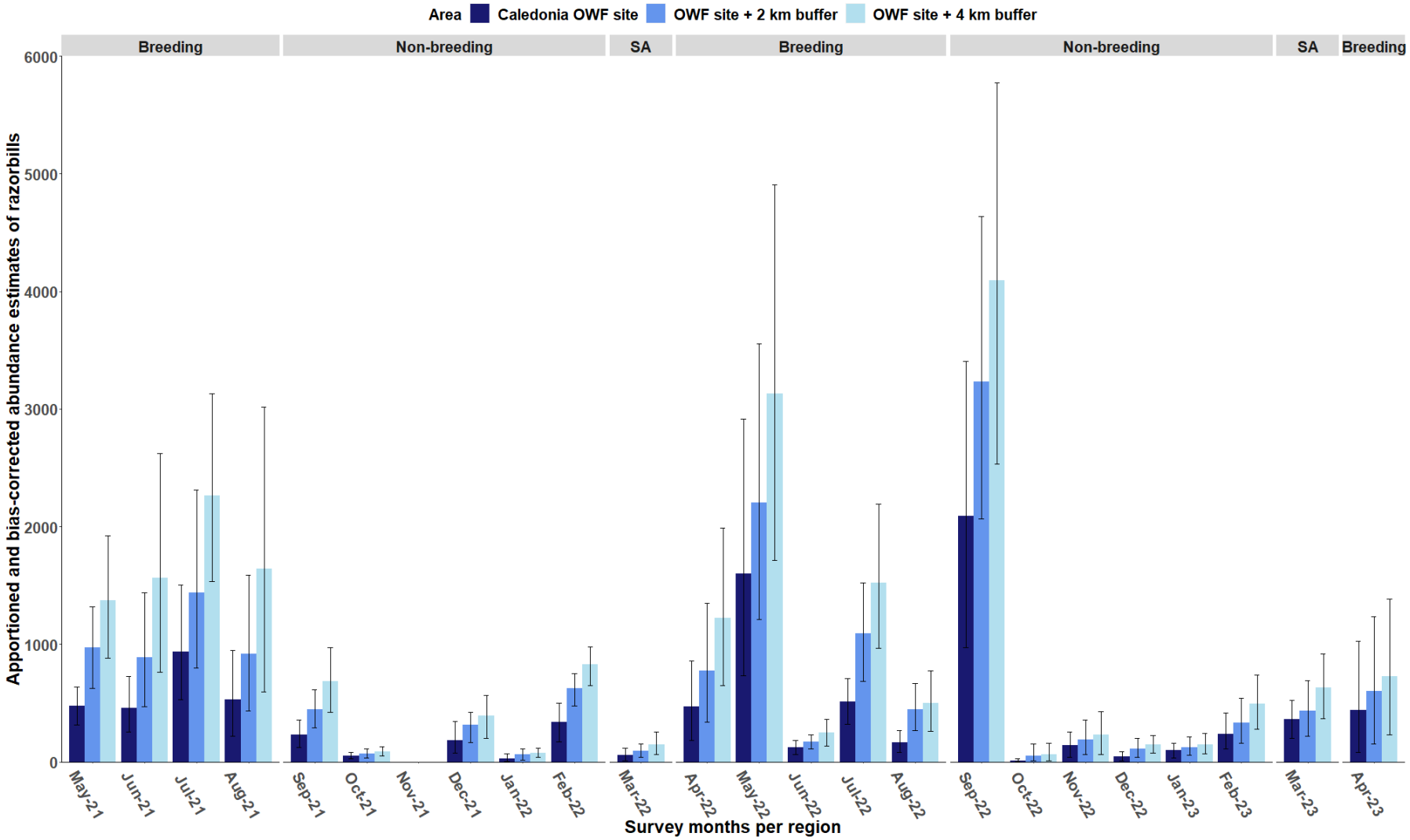



**Figure 24 Bar plot of the monthly apportioned abundances estimates (with 95% confidence intervals) of total razorbills recorded in each reporting region of the Survey Area, during the May 2021 to April 2023 survey period. Razorbill seasonal periods are also displayed. SA stands for breeding site attendance.**

### *Caledonia North*

A total of 1,395 razorbills were recorded in Caledonia North Survey Area during both years of baseline surveys (Table 9). Razorbills were recorded in every survey apart from November 2021 (Table 9, Table 69, Figure 25). Highest abundances were recorded during the non-breeding period (September to February). Peak of abundance were recorded in September 2022 (Table 69, Figure 25):

- 171 individuals were recorded in Caledonia North, resulting in an unapportioned mean abundance estimate of 981 [419; 1,584], an apportioned mean abundance estimate of 1,256 [506; 2,086] and an apportioned and availability bias-corrected mean abundance estimate of 1,519 [612; 2,522] individuals. These equated to mean density estimates of 4.49 (unapportioned), 5.75 (apportioned) and 6.95 (apportioned and availability bias-corrected) birds/km$^2$.
- 276 individuals were recorded in Caledonia North plus 2 km buffer, resulting in an unapportioned mean abundance estimate of 1,603 [865; 2,434], an apportioned mean abundance estimate of 2,021 [1,043; 3,201] and an apportioned and availability bias-corrected mean abundance estimate of 2,438 [1,262; 3,850] individuals. These equated to mean density estimates of 4.27 (unapportioned), 5.38 (apportioned) and 6.49 (apportioned and availability bias-corrected) birds/km$^2$.
- 371 individuals were recorded in Caledonia North Survey Area, resulting in an unapportioned mean abundance estimate of 2,161 [1,089; 3,227], an apportioned mean abundance estimate of 2,665 [1,314; 4,158] and an apportioned and availability bias-corrected mean abundance estimate of 3,215 [1,589; 5,006] individuals. These equated to mean density estimates of 3.88 (unapportioned), 4.78 (apportioned) and 5.77 (apportioned and availability bias-corrected) birds/km$^2$.

During the breeding site attendance period (March), razorbills were recorded in low numbers, with a peak number in March 2023: (Table 69, Figure 25):

- 18 individuals were recorded in Caledonia North, resulting in an unapportioned mean abundance estimate of 105 [29; 199], an apportioned mean abundance estimate of 119 [34; 231] and an apportioned and availability bias-corrected mean abundance estimate of 141 [41; 273] individuals. These equated to mean density estimates of 0.48 (unapportioned), 0.54 (apportioned) and 0.65 (apportioned and availability bias-corrected) birds/km$^2$.
- 32 individuals were recorded in Caledonia North plus 2 km buffer, resulting in an unapportioned mean abundance estimate of 186 [70; 330], an apportioned mean abundance estimate of 204 [65; 372] and an apportioned and availability bias-corrected mean abundance estimate of 236 [77; 426] individuals. These equated to mean density estimates of 0.50 (unapportioned), 0.54 (apportioned) and 0.63 (apportioned and availability bias-corrected) birds/km$^2$.
- 53 individuals were recorded in Caledonia North Survey Area, resulting in an unapportioned mean abundance estimate of 311 [170; 458], an apportioned mean abundance estimate of 340 [157; 543] and an apportioned and availability bias-corrected mean abundance estimate of 399 [188; 630] individuals. These equated to mean density estimates of 0.56 (unapportioned), 0.61 (apportioned) and 0.72 (apportioned and availability bias-corrected) birds/km$^2$.

During the two non-breeding seasons covered by the baseline surveys, peak mean apportioned and availability bias-corrected abundances of razorbills within Caledonia North Survey Area occurred in September and February/March. The largest overall peak was recorded in September 2022, when mean apportioned and availability bias-corrected abundances were considerably larger than in any other survey during the non-breeding season for this species. During the late autumn and winter months, mean apportioned and availability bias-corrected abundances of razorbills was consistently low in Caledonia North Survey Area reporting regions, with higher mean apportioned and availability

bias-corrected abundances of razorbills occurring in February 2022, and March 2023. The timing of the non-breeding season peaks indicates that the Survey Area may be relatively important to post-breeding aggregations of birds (likely from a number of breeding colonies in the wider area), and birds attending colonies in the pre-breeding period.

Reductions in mean apportioned and availability bias-corrected abundance relative to the peak were between 81% to >99.5%, with many of the surveys recording reductions in mean abundances at the upper end of this range when compared with the peak month. This is largely a reflection of the fact that the September 2022 peak was very large relative to the other mean apportioned and availability bias-corrected abundances recorded for razorbill in Caledonia North Survey Area and reporting regions during the non-breeding season.

During the breeding season (April to mid-August, with birds attending colonies from March onwards) Peak abundance was recorded in May 2022 (Table 69, Figure 25):

- 133 individuals were recorded in Caledonia North, resulting in an unapportioned mean abundance estimate of 772 [395; 1,352], an apportioned mean abundance estimate of 850 [403; 1,548] and an apportioned and availability bias-corrected mean abundance estimate of 1,026 [488; 1,867] individuals. These equated to mean density estimates of 3.54 (unapportioned), 3.89 (apportioned) and 4.63 (apportioned and availability bias-corrected) birds/km$^2$.
- 214 individuals were recorded in Caledonia North plus 2 km buffer, resulting in an unapportioned mean abundance estimate of 1,219 [763; 1,822], an apportioned mean abundance estimate of 1,338 [804; 1,995] and an apportioned and availability bias-corrected mean abundance estimate of 1,618 [974; 2,409] individuals. These equated to mean density estimates of 3.25 (unapportioned), 3.56 (apportioned) and 4.31 (apportioned and availability bias-corrected) birds/km$^2$.
- 314 individuals were recorded in Caledonia North Survey Area, resulting in an unapportioned mean abundance estimate of 1,826 [988; 2,797], an apportioned mean abundance estimate of 1,998 [1,036; 3,092] and an apportioned and availability bias-corrected mean abundance estimate of 2,417 [1,254; 3,737] individuals. These equated to mean density estimates of 3.28 (unapportioned), 3.58 (apportioned) and 4.33 (apportioned and availability bias-corrected) birds/km$^2$.

During the 2021 breeding season, mean apportioned and availability bias-corrected razorbill abundance between May and August were relatively consistent, with Caledonia North Survey Area peak occurring in July 2021. During the 2022 breeding season, a large peak in apportioned and availability bias-corrected mean razorbill abundances (which was the overall breeding season peak month by a larger margin) was recorded in May 2022. Abundances were very low in June 2022 and in August 2022, with a larger apportioned and availability bias-corrected mean abundance in July 2022 across Caledonia North Survey Area. The reasons for the differences in temporal patterns between the 2021 and 2022 breeding seasons within Caledonia North Survey Area are unclear.

Reductions in mean apportioned and availability bias-corrected abundance in the breeding season surveys outside the peak survey month varied from 64% to 97%, with most surveys falling somewhere in the middle of the two extremes of this range. This indicates that the mean apportioned abundances were somewhat variable throughout the breeding season when compared with the peak mean apportioned abundance for this season during the baseline survey period.

Precision values were quite variable throughout the survey period (Table 69). CV values of ≤ 0.16 were reported in two of 22 baseline surveys across Caledonia North, with lower precision values (i.e. higher levels of precision) coinciding with surveys where higher numbers of razorbills were recorded (Table 69). For Caledonia North plus buffer regions, CV values were generally lower than the corresponding CV values for Caledonia North, indicating higher precision within these reporting regions (Table 69).

**Table 69** **Raw counts, unapportioned, apportioned, and apportioned and availability bias-corrected abundance and density estimates (birds per km$^2$) of razorbills in Caledonia North, Caledonia North plus 2 km buffer and Caledonia North Survey Area during the May 2021 to April 2023 survey period. Colour gradients follow the ascending order of razorbill raw counts per season, with light yellow to orange (peak number) for the breeding season months (April to mid-August) and light blue to royal blue (peak number) for the wintering months (September to February). No colours were attributed to the breeding site attendance period (March)**

| Survey | Raw count | Total unapportioned | | | | | Total apportioned | | | | Total apportioned and bias-corrected | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Abundance | LCL | UCL | Precision (CV) | Density (km$^2$) | Abundance | LCL | UCL | Density (km$^2$) | Abundance | LCL | UCL | Density (km$^2$) |
| **a) Caledonia North** | | | | | | | | | | | | | | |
| **May-21** | 30 | 175 | 70 | 286 | 0.18 | 0.80 | 192 | 70 | 317 | 0.88 | 232 | 85 | 384 | 1.06 |
| **Jun-21** | 14 | 83 | 30 | 148 | 0.27 | 0.38 | 97 | 21 | 196 | 0.44 | 112 | 24 | 226 | 0.51 |
| **Jul-21** | 28 | 166 | 89 | 249 | 0.19 | 0.76 | 179 | 92 | 279 | 0.82 | 217 | 112 | 338 | 0.99 |
| **Aug-21** | 22 | 127 | 35 | 226 | 0.21 | 0.58 | 204 | 68 | 360 | 0.93 | 246 | 83 | 436 | 1.13 |
| **Sep-21** | 12 | 70 | 29 | 104 | 0.29 | 0.32 | 103 | 38 | 175 | 0.47 | 125 | 46 | 211 | 0.57 |
| **Oct-21** | 1 | 6 | 1 | 18 | 1.00 | 0.03 | 8 | 1 | 26 | 0.04 | 10 | 1 | 32 | 0.05 |
| **Dec-21** | 2 | 12 | 2 | 35 | 0.71 | 0.05 | 56 | 9 | 144 | 0.26 | 68 | 11 | 175 | 0.31 |
| **Feb-22** | 16 | 86 | 27 | 151 | 0.25 | 0.39 | 206 | 79 | 355 | 0.94 | 250 | 95 | 430 | 1.14 |
| **Mar-22** | 3 | 16 | 3 | 43 | 0.58 | 0.07 | 25 | 4 | 64 | 0.11 | 30 | 4 | 77 | 0.14 |
| **Apr-22** | 34 | 195 | 52 | 379 | 0.17 | 0.89 | 217 | 49 | 435 | 0.99 | 263 | 59 | 526 | 1.2 |
| **May-22** | 133 | 772 | 395 | 1,352 | 0.09 | 3.54 | 850 | 403 | 1,548 | 3.89 | 1,026 | 488 | 1,867 | 4.7 |
| **Jun-22** | 8 | 46 | 11 | 91 | 0.35 | 0.21 | 47 | 11 | 95 | 0.22 | 57 | 13 | 115 | 0.26 |
| **Jul-22** | 30 | 176 | 88 | 258 | 0.18 | 0.81 | 204 | 99 | 327 | 0.94 | 248 | 120 | 395 | 1.13 |
| **Aug-22** | 8 | 46 | 12 | 87 | 0.35 | 0.21 | 62 | 20 | 114 | 0.28 | 75 | 25 | 138 | 0.34 |
| **Sep-22** | 171 | 981 | 419 | 1,584 | 0.08 | 4.49 | 1,256 | 506 | 2,086 | 5.75 | 1,519 | 612 | 2,522 | 6.95 |
| **Oct-22** | 1 | 6 | 1 | 17 | 1.00 | 0.03 | 15 | 3 | 43 | 0.07 | 18 | 3 | 52 | 0.08 |
| **Nov-22** | 3 | 18 | 3 | 35 | 0.58 | 0.08 | 73 | 12 | 136 | 0.34 | 88 | 15 | 161 | 0.4 |
| **Dec-22** | 2 | 12 | 2 | 29 | 0.71 | 0.05 | 16 | 2 | 41 | 0.07 | 19 | 3 | 50 | 0.09 |
| **Jan-23** | 6 | 35 | 6 | 69 | 0.41 | 0.16 | 38 | 6 | 80 | 0.18 | 46 | 8 | 97 | 0.21 |
| **Feb-23** | 7 | 40 | 7 | 86 | 0.38 | 0.18 | 45 | 7 | 105 | 0.20 | 48 | 8 | 114 | 0.22 |
| **Mar-23** | 18 | 105 | 29 | 199 | 0.24 | 0.48 | 119 | 34 | 231 | 0.54 | 141 | 41 | 273 | 0.65 |
| **Apr-23** | 3 | 17 | 3 | 28 | 0.58 | 0.08 | 192 | 70 | 317 | 0.88 | 26 | 8 | 44 | 0.12 |
| **b) Caledonia North plus 2 km buffer** | | | | | | | | | | | | | | |
| **May-21** | 61 | 349 | 229 | 475 | 0.13 | 0.93 | 384 | 240 | 509 | 1.02 | 465 | 290 | 617 | 1.24 |
| **Jun-21** | 31 | 180 | 93 | 278 | 0.18 | 0.48 | 210 | 96 | 352 | 0.56 | 246 | 115 | 407 | 0.66 |
| **Jul-21** | 56 | 323 | 231 | 438 | 0.13 | 0.86 | 341 | 244 | 456 | 0.91 | 413 | 296 | 552 | 1.1 |

| Survey | Raw count | Total unapportioned | | | | | Total apportioned | | | | Total apportioned and bias-corrected | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Abundance | LCL | UCL | Precision (CV) | Density ($km^2$) | Abundance | LCL | UCL | Density ($km^2$) | Abundance | LCL | UCL | Density ($km^2$) |
| **Aug-21** | 37 | 210 | 102 | 323 | 0.16 | 0.56 | 334 | 153 | 511 | 0.89 | 404 | 185 | 619 | 1.08 |
| **Sep-21** | 17 | 97 | 23 | 188 | 0.24 | 0.26 | 159 | 46 | 313 | 0.42 | 192 | 55 | 379 | 0.51 |
| **Oct-21** | 1 | 6 | 1 | 17 | 1.00 | 0.02 | 8 | 1 | 24 | 0.02 | 10 | 2 | 29 | 0.03 |
| **Dec-21** | 2 | 11 | 2 | 34 | 0.71 | 0.03 | 96 | 45 | 214 | 0.26 | 116 | 54 | 259 | 0.31 |
| **Jan-22** | 1 | 6 | 1 | 17 | 1.00 | 0.02 | 8 | 1 | 25 | 0.02 | 10 | 1 | 30 | 0.03 |
| **Feb-22** | 29 | 156 | 80 | 236 | 0.19 | 0.42 | 375 | 216 | 544 | 1.00 | 454 | 261 | 659 | 1.21 |
| **Mar-22** | 5 | 27 | 5 | 53 | 0.45 | 0.07 | 47 | 8 | 89 | 0.13 | 57 | 9 | 108 | 0.15 |
| **Apr-22** | 49 | 275 | 90 | 489 | 0.14 | 0.73 | 325 | 93 | 600 | 0.87 | 394 | 113 | 726 | 1.05 |
| **May-22** | 214 | 1,219 | 763 | 1,822 | 0.07 | 3.25 | 1,338 | 804 | 1,995 | 3.56 | 1,618 | 974 | 2,409 | 4.31 |
| **Jun-22** | 12 | 69 | 23 | 121 | 0.29 | 0.18 | 71 | 23 | 126 | 0.19 | 86 | 28 | 152 | 0.23 |
| **Jul-22** | 54 | 309 | 166 | 452 | 0.14 | 0.82 | 354 | 164 | 545 | 0.94 | 427 | 199 | 657 | 1.14 |
| **Aug-22** | 24 | 137 | 74 | 200 | 0.20 | 0.37 | 182 | 86 | 281 | 0.48 | 220 | 104 | 340 | 0.59 |
| **Sep-22** | 276 | 1,603 | 865 | 2,434 | 0.06 | 4.27 | 2,021 | 1,043 | 3,201 | 5.38 | 2,438 | 1,262 | 3,850 | 6.49 |
| **Oct-22** | 7 | 41 | 7 | 112 | 0.38 | 0.11 | 58 | 10 | 161 | 0.15 | 70 | 12 | 195 | 0.19 |
| **Nov-22** | 6 | 35 | 12 | 58 | 0.41 | 0.09 | 113 | 33 | 195 | 0.30 | 135 | 40 | 232 | 0.36 |
| **Dec-22** | 6 | 35 | 6 | 65 | 0.41 | 0.09 | 46 | 14 | 94 | 0.12 | 56 | 17 | 114 | 0.15 |
| **Jan-23** | 7 | 41 | 7 | 82 | 0.38 | 0.11 | 44 | 12 | 93 | 0.12 | 54 | 15 | 112 | 0.14 |
| **Feb-23** | 13 | 74 | 13 | 131 | 0.28 | 0.20 | 82 | 18 | 171 | 0.22 | 92 | 20 | 190 | 0.24 |
| **Mar-23** | 32 | 186 | 70 | 330 | 0.18 | 0.50 | 204 | 65 | 372 | 0.54 | 236 | 77 | 426 | 0.63 |
| **Apr-23** | 8 | 46 | 17 | 80 | 0.35 | 0.12 | 58 | 14 | 123 | 0.15 | 69 | 17 | 146 | 0.18 |
| **c) Caledonia North Survey Area** | | | | | | | | | | | | | | |
| **May-21** | 99 | 579 | 369 | 819 | 0.10 | 1.04 | 646 | 411 | 900 | 1.16 | 782 | 497 | 1,090 | 1.4 |
| **Jun-21** | 47 | 278 | 142 | 432 | 0.15 | 0.50 | 329 | 170 | 532 | 0.59 | 390 | 204 | 621 | 0.7 |
| **Jul-21** | 112 | 678 | 491 | 902 | 0.09 | 1.22 | 719 | 521 | 972 | 1.29 | 868 | 631 | 1,169 | 1.56 |
| **Aug-21** | 44 | 255 | 99 | 406 | 0.15 | 0.46 | 436 | 204 | 693 | 0.78 | 528 | 246 | 840 | 0.95 |
| **Sep-21** | 24 | 140 | 70 | 239 | 0.20 | 0.25 | 212 | 88 | 392 | 0.38 | 257 | 107 | 475 | 0.46 |
| **Oct-21** | 2 | 12 | 2 | 29 | 0.71 | 0.02 | 15 | 2 | 37 | 0.03 | 18 | 3 | 45 | 0.03 |
| **Dec-21** | 2 | 12 | 2 | 35 | 0.71 | 0.02 | 96 | 20 | 233 | 0.17 | 116 | 25 | 283 | 0.21 |
| **Jan-22** | 1 | 6 | 1 | 17 | 1.00 | 0.01 | 8 | 1 | 25 | 0.01 | 10 | 1 | 30 | 0.02 |
| **Feb-22** | 37 | 204 | 110 | 297 | 0.16 | 0.37 | 514 | 303 | 736 | 0.92 | 623 | 366 | 892 | 1.12 |
| **Mar-22** | 9 | 49 | 22 | 86 | 0.33 | 0.09 | 99 | 29 | 182 | 0.18 | 120 | 35 | 221 | 0.22 |
| **Apr-22** | 82 | 472 | 236 | 771 | 0.11 | 0.85 | 535 | 241 | 904 | 0.96 | 643 | 291 | 1,082 | 1.15 |

| Survey | Raw count | Total unapportioned | | | | | Total apportioned | | | | Total apportioned and bias-corrected | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Abundance | LCL | UCL | Precision (CV) | Density ($km^2$) | Abundance | LCL | UCL | Density ($km^2$) | Abundance | LCL | UCL | Density ($km^2$) |
| **May-22** | **314** | **1,826** | **988** | **2,797** | **0.06** | **3.28** | **1,998** | **1,036** | **3,092** | **3.58** | **2,417** | **1,254** | **3,737** | **4.33** |
| **Jun-22** | 22 | 127 | 58 | 196 | 0.21 | 0.23 | 132 | 61 | 216 | 0.24 | 158 | 74 | 254 | 0.28 |
| **Jul-22** | 77 | 451 | 293 | 603 | 0.11 | 0.81 | 501 | 309 | 705 | 0.90 | 604 | 374 | 847 | 1.08 |
| **Aug-22** | 30 | 172 | 86 | 252 | 0.18 | 0.31 | 247 | 122 | 377 | 0.44 | 299 | 148 | 456 | 0.54 |
| **Sep-22** | **371** | **2,161** | **1,089** | **3,227** | **0.05** | **3.88** | **2,665** | **1,314** | **4,158** | **4.78** | **3,215** | **1,589** | **5,006** | **5.77** |
| **Oct-22** | 8 | 47 | 8 | 117 | 0.35 | 0.08 | 61 | 10 | 159 | 0.11 | 74 | 12 | 193 | 0.13 |
| **Nov-22** | 9 | 53 | 12 | 100 | 0.33 | 0.10 | 146 | 39 | 284 | 0.26 | 174 | 47 | 338 | 0.31 |
| **Dec-22** | 9 | 53 | 18 | 94 | 0.33 | 0.10 | 68 | 22 | 125 | 0.12 | 82 | 27 | 152 | 0.15 |
| **Jan-23** | 12 | 71 | 24 | 118 | 0.29 | 0.13 | 76 | 25 | 138 | 0.14 | 92 | 30 | 167 | 0.17 |
| **Feb-23** | 17 | 98 | 40 | 168 | 0.24 | 0.18 | 111 | 39 | 204 | 0.20 | 125 | 45 | 227 | 0.22 |
| **Mar-23** | 53 | 311 | 170 | 458 | 0.14 | 0.56 | 340 | 157 | 543 | 0.61 | 399 | 188 | 630 | 0.72 |
| **Apr-23** | 14 | 80 | 34 | 137 | 0.27 | 0.14 | 91 | 30 | 163 | 0.16 | 105 | 36 | 188 | 0.19 |

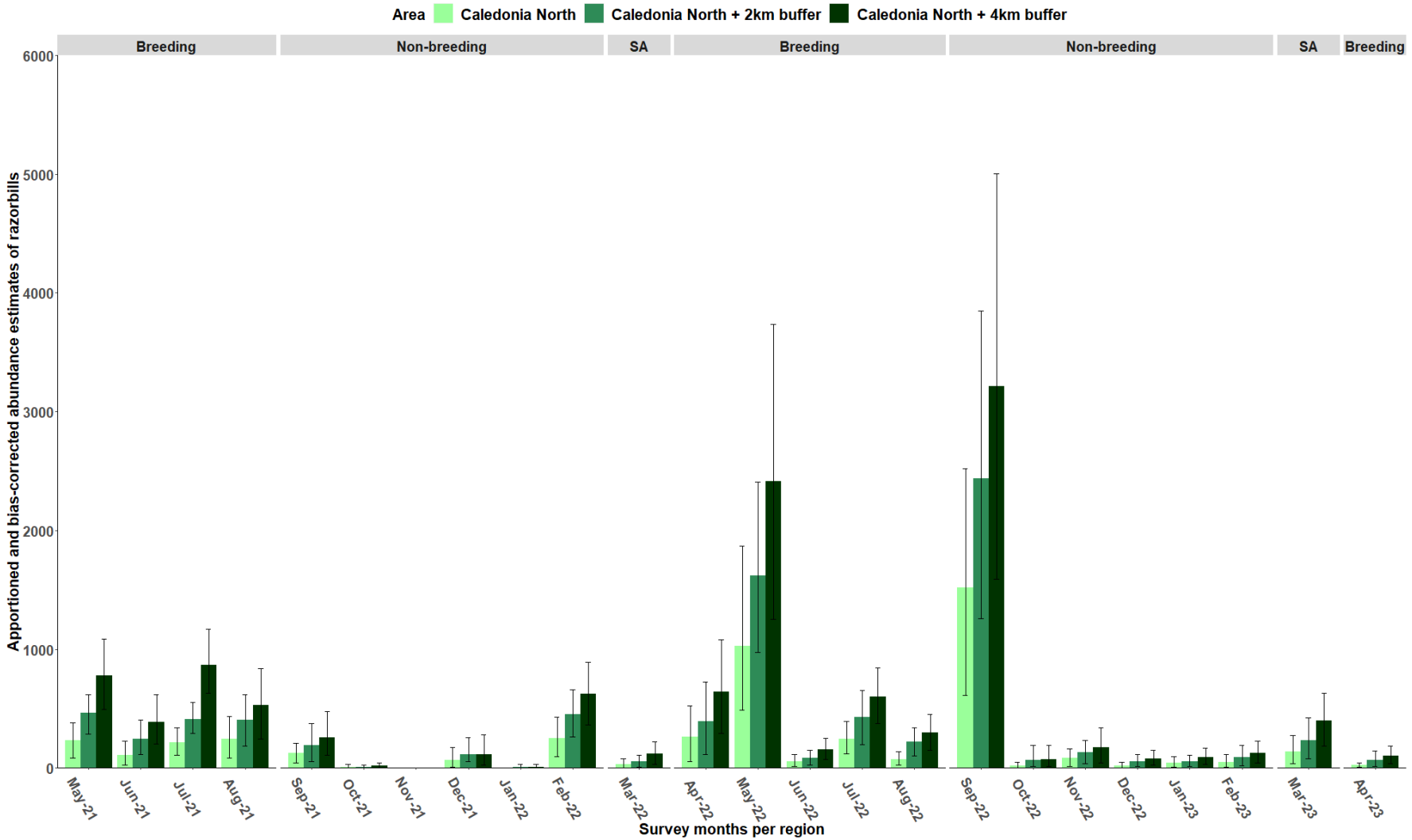



**Figure 25 Bar plot of the monthly apportioned abundances estimates (with 95% confidence intervals) of total razorbills recorded in each reporting region of Caledonia North Survey Area, during the May 2021 to April 2023 survey period. Razorbill seasonal periods are also displayed. SA stands for breeding site attendance.**

### *Caledonia South*

A total of 1,617 razorbills were recorded in Caledonia South Survey Area during both years of baseline surveys (Table 10). Razorbills were recorded in every survey apart from November 2021 (Table 70, Figure 26). In contrast to Caledonia North and the Survey Area, highest abundances of razorbills were recorded during the breeding season (April to mid-August, with birds attending colonies from March onwards). Peak breeding season abundances were recorded during in July 2021 (Table 70, Figure 26):

- 100 individuals were recorded in Caledonia South, resulting in an unapportioned mean abundance estimate of 586 [270; 1,003], an apportioned mean abundance estimate of 607 [288; 1,023] and an apportioned and availability bias-corrected mean abundance estimate of 735 [348; 1,239] individuals. These equated to mean density estimates of 2.79 (unapportioned), 2.88 (apportioned) and 3.49 (apportioned and availability bias-corrected) birds/km$^2$.
- 157 individuals were recorded in Caledonia South plus 2 km buffer, resulting in an unapportioned mean abundance estimate of 913 [425; 1,699], an apportioned mean abundance estimate of 958 [481; 1,645] and an apportioned and availability bias-corrected mean abundance estimate of 1,160 [582; 1,993] individuals. These equated to mean density estimates of 2.54 (unapportioned), 2.66 (apportioned) and 3.22 (apportioned and availability bias-corrected) birds/km$^2$.
- 244 individuals were recorded in Caledonia South Survey Area, resulting in an unapportioned mean abundance estimate of 1,465 [895; 2,210], an apportioned mean abundance estimate of 1,530 [960; 2,320] and an apportioned and availability bias-corrected mean abundance estimate of 1,853 [1,163; 2,809] individuals. These equated to mean density estimates of 2.75 (unapportioned), 2.87 (apportioned) and 3.47 (apportioned and availability bias-corrected) birds/km$^2$.

During the 2021 breeding season, mean apportioned and availability bias-corrected razorbill abundance within Caledonia South Survey Area increased between May and July, with the breeding season peak for the baseline survey period occurring in July 2021. Razorbill mean apportioned and availability bias-corrected abundance declined between July 2021 and August 2021. During the 2022 breeding season, the temporal pattern observed was quite different to the 2021 breeding season, with low numbers of birds present in June 2022 and August 2022, and higher abundances recorded in April 2022, May 2022 and August 2022. The reasons for the differences in temporal patterns between the 2021 and 2022 breeding seasons within Caledonia South Survey Area are unclear.

Reductions in mean apportioned and availability bias-corrected abundance in the breeding season surveys outside the peak survey month varied from 22% to 93%, with most surveys falling somewhere in the middle of the two extremes of this range. This indicates that the mean apportioned abundances were somewhat variable throughout the breeding season surveys when compared with the peak mean apportioned abundance for this season during the baseline survey period.

During the non-breeding period, peak numbers were recorded in September 2022 (Table 70, Figure 26):

- 79 individuals were recorded in Caledonia South, resulting in an unapportioned mean abundance estimate of 461 [268; 665], an apportioned mean abundance estimate of 529 [288; 774] and an apportioned and availability bias-corrected mean abundance estimate of 639 [348; 932] individuals. These equated to mean density estimates of 2.19 (unapportioned), 2.51 (apportioned) and 3.04 (apportioned and availability bias-corrected) birds/km$^2$.
- 163 individuals were recorded in Caledonia South plus 2 km buffer, resulting in an unapportioned mean abundance estimate of 931 [674; 1,171], an apportioned mean abundance estimate of 1,067 [803; 1,382] and an apportioned and availability bias-corrected mean abundance estimate of 1,286 [970; 1,659] individuals. These equated to mean density

estimates of 2.59 (unapportioned), 2.96 (apportioned) and 3.57 (apportioned and availability bias-corrected) birds/km$^2$.

- 243 individuals were recorded in Caledonia South Survey Area, resulting in an unapportioned mean abundance estimate of 1,418 [1,120; 1,786], an apportioned mean abundance estimate of 1,586 [1,254; 1,983] and an apportioned and availability bias-corrected mean abundance estimate of 1,915 [1,517; 2,384] individuals. These equated to mean density estimates of 2.66 (unapportioned), 2.97 (apportioned) and 3.59 (apportioned and availability bias-corrected) birds/km$^2$.

During the breeding site attendance period (March), razorbills were recorded in low numbers in Caledonia South Survey Area, with a peak abundance in March 2023: (Table 70, Figure 26):

- 30 individuals were recorded in Caledonia South, resulting in an unapportioned mean abundance estimate of 174 [104; 255], an apportioned mean abundance estimate of 182 [92; 288] and an apportioned and availability bias-corrected mean abundance estimate of 217 [110; 340] individuals. These equated to mean density estimates of 0.83 (unapportioned), 0.87 (apportioned) and 1.03 (apportioned and availability bias-corrected) birds/km$^2$.
- 35 individuals were recorded in Caledonia South plus 2 km buffer, resulting in an unapportioned mean abundance estimate of 202 [98; 311], an apportioned mean abundance estimate of 219 [102; 367] and an apportioned and availability bias-corrected mean abundance estimate of 261 [122; 435] individuals. These equated to mean density estimates of 0.56 (unapportioned), 0.61 (apportioned) and 0.73 (apportioned and availability bias-corrected) birds/km$^2$.
- 57 individuals were recorded in Caledonia South Survey Area, resulting in an unapportioned mean abundance estimate of 332 [221; 449], an apportioned mean abundance estimate of 360 [185; 534] and an apportioned and availability bias-corrected mean abundance estimate of 425 [222; 627] individuals. These equated to mean density estimates of 0.62 (unapportioned), 0.67 (apportioned) and 0.8 (apportioned and availability bias-corrected) birds/km$^2$.

During the two non-breeding seasons covered by the baseline surveys, peak mean apportioned and availability bias-corrected abundances of razorbills occurred within Caledonia South Survey Area in September. The largest overall peak was in September 2022, when mean apportioned and availability bias-corrected abundances were considerably larger than in any other survey during the non-breeding season for this species. During the late autumn and winter months, mean apportioned and availability bias-corrected abundances of razorbills was generally low in Caledonia South Survey Area reporting regions (with the exception of December 2021), with higher mean apportioned and availability bias-corrected abundances of razorbills occurring in February 2022, February 2023, and March 2023.

Reductions in mean apportioned and availability bias-corrected abundance relative to the peak were between 66% to >99.5%, with many of the surveys recording reductions in mean abundances at the upper end of this range when compared with the peak month. This reflects the fact that the September 2022 peak was very large relative to the other peak mean apportioned and availability bias-corrected abundances recorded for razorbill during the non-breeding season.

Precision values were quite variable for this species throughout the survey period (Table 70). CV values of ≤ 0.16 were reported in five of 22 baseline surveys across Caledonia South, with lower precision values (i.e. higher levels of precision) coinciding with surveys where higher numbers of birds were recorded (Table 70). For Caledonia South plus buffer regions, CV values were generally lower than the corresponding CV values for Caledonia South, indicating higher precision within these reporting regions (Table 70).

**Table 70** **Raw counts, unapportioned, apportioned, and apportioned and availability bias-corrected abundance and density estimates (birds per km$^2$) of razorbills in Caledonia South, Caledonia South plus 2 km buffer and Caledonia South Survey Area during the May 2021 to April 2023 survey period. Colour gradients follow the ascending order of razorbill raw counts per season, with light yellow to orange (peak number) for the breeding season months (April to mid-August) and light blue to royal blue (peak number) for the wintering months (September to February). No colours were attributed to the breeding site attendance period (March)**

| Survey | Raw count | Total unapportioned | | | | | Total apportioned | | | | Total apportioned and bias-corrected | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Abundance | LCL | UCL | Precision (CV) | Density (km$^2$) | Abundance | LCL | UCL | Density (km$^2$) | Abundance | LCL | UCL | Density (km$^2$) |
| **a) Caledonia South** | | | | | | | | | | | | | | |
| **May-21** | 33 | 192 | 93 | 303 | 0.17 | 0.91 | 206 | 89 | 321 | 0.98 | 249 | 108 | 389 | 1.18 |
| **Jun-21** | 39 | 227 | 116 | 355 | 0.16 | 1.08 | 284 | 128 | 480 | 1.35 | 344 | 155 | 581 | 1.63 |
| **Jul-21** | **100** | **586** | **270** | **1,003** | **0.10** | **2.79** | **607** | **288** | **1,023** | **2.88** | **735** | **348** | **1,239** | **3.49** |
| **Aug-21** | 13 | 75 | 23 | 127 | 0.28 | 0.36 | 188 | 39 | 426 | 0.89 | 228 | 47 | 516 | 1.08 |
| **Sep-21** | 13 | 75 | 29 | 128 | 0.28 | 0.36 | 100 | 42 | 161 | 0.47 | 119 | 50 | 192 | 0.57 |
| **Oct-21** | 5 | 29 | 12 | 41 | 0.45 | 0.14 | 36 | 13 | 53 | 0.17 | 43 | 16 | 64 | 0.2 |
| **Dec-21** | 2 | 12 | 2 | 23 | 0.71 | 0.06 | 106 | 40 | 207 | 0.50 | 128 | 48 | 250 | 0.61 |
| **Jan-22** | 3 | 17 | 3 | 46 | 0.58 | 0.08 | 23 | 5 | 52 | 0.11 | 27 | 6 | 63 | 0.13 |
| **Feb-22** | 7 | 38 | 16 | 65 | 0.38 | 0.18 | 81 | 31 | 138 | 0.38 | 98 | 38 | 167 | 0.47 |
| **Mar-22** | 2 | 11 | 2 | 27 | 0.71 | 0.05 | 17 | 4 | 55 | 0.08 | 20 | 4 | 63 | 0.09 |
| **Apr-22** | 23 | 132 | 52 | 225 | 0.21 | 0.63 | 165 | 55 | 291 | 0.78 | 197 | 66 | 345 | 0.93 |
| **May-22** | 74 | 427 | 191 | 705 | 0.12 | 2.03 | 474 | 191 | 810 | 2.25 | 573 | 231 | 978 | 2.72 |
| **Jun-22** | 9 | 52 | 29 | 81 | 0.33 | 0.25 | 54 | 30 | 78 | 0.25 | 65 | 36 | 94 | 0.31 |
| **Jul-22** | 35 | 204 | 99 | 321 | 0.17 | 0.97 | 225 | 109 | 374 | 1.07 | 272 | 133 | 453 | 1.29 |
| **Aug-22** | 12 | 69 | 35 | 98 | 0.29 | 0.33 | 78 | 37 | 122 | 0.37 | 95 | 45 | 148 | 0.45 |
| **Sep-22** | **79** | **461** | **268** | **665** | **0.11** | **2.19** | **529** | **288** | **774** | **2.51** | **639** | **348** | **932** | **3.04** |
| **Nov-22** | 2 | 12 | 2 | 35 | 0.71 | 0.06 | 43 | 7 | 105 | 0.21 | 52 | 9 | 127 | 0.25 |
| **Dec-22** | 3 | 18 | 3 | 41 | 0.58 | 0.09 | 23 | 4 | 54 | 0.11 | 28 | 5 | 66 | 0.13 |
| **Jan-23** | 7 | 41 | 12 | 76 | 0.38 | 0.19 | 42 | 7 | 80 | 0.20 | 51 | 9 | 96 | 0.24 |
| **Feb-23** | 25 | 143 | 68 | 234 | 0.20 | 0.68 | 153 | 71 | 264 | 0.73 | 184 | 86 | 315 | 0.87 |
| **Mar-23** | 30 | 174 | 104 | 255 | 0.18 | 0.83 | 182 | 92 | 288 | 0.87 | 217 | 110 | 340 | 1.03 |
| **Apr-23** | 58 | 330 | 63 | 722 | 0.13 | 1.57 | 347 | 60 | 839 | 1.65 | 414 | 72 | 1,000 | 1.97 |
| **b) Caledonia South plus 2 km buffer** | | | | | | | | | | | | | | |
| **May-21** | 73 | 422 | 260 | 578 | 0.12 | 1.17 | 455 | 287 | 654 | 1.27 | 551 | 348 | 792 | 1.53 |
| **Jun-21** | 70 | 406 | 215 | 661 | 0.12 | 1.13 | 564 | 368 | 965 | 1.57 | 682 | 445 | 1,164 | 1.9 |
| **Jul-21** | **157** | **913** | **425** | **1,699** | **0.08** | **2.54** | **958** | **481** | **1,645** | **2.66** | **1,160** | **582** | **1,993** | **3.22** |

| Survey | Raw count | Total unapportioned | | | | | Total apportioned | | | | Total apportioned and bias-corrected | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Abundance | LCL | UCL | Precision (CV) | Density (km$^2$) | Abundance | LCL | UCL | Density (km$^2$) | Abundance | LCL | UCL | Density (km$^2$) |
| **Aug-21** | 19 | 109 | 46 | 172 | 0.23 | 0.30 | 367 | 304 | 721 | 1.02 | 445 | 369 | 873 | 1.24 |
| **Sep-21** | 39 | 225 | 144 | 329 | 0.16 | 0.63 | 266 | 174 | 385 | 0.74 | 320 | 210 | 461 | 0.89 |
| **Oct-21** | 8 | 46 | 23 | 70 | 0.35 | 0.13 | 59 | 36 | 95 | 0.16 | 72 | 44 | 115 | 0.2 |
| **Dec-21** | 5 | 29 | 12 | 46 | 0.45 | 0.08 | 193 | 176 | 250 | 0.54 | 233 | 213 | 302 | 0.65 |
| **Jan-22** | 6 | 34 | 11 | 63 | 0.41 | 0.09 | 45 | 22 | 84 | 0.13 | 55 | 27 | 102 | 0.15 |
| **Feb-22** | 19 | 101 | 64 | 144 | 0.23 | 0.28 | 199 | 157 | 266 | 0.55 | 241 | 190 | 322 | 0.67 |
| **Mar-22** | 4 | 21 | 5 | 37 | 0.50 | 0.06 | 38 | 21 | 79 | 0.11 | 45 | 25 | 92 | 0.13 |
| **Apr-22** | 51 | 292 | 126 | 492 | 0.14 | 0.81 | 355 | 184 | 624 | 0.99 | 422 | 220 | 741 | 1.17 |
| **May-22** | 109 | 625 | 327 | 952 | 0.10 | 1.74 | 687 | 389 | 1,063 | 1.91 | 830 | 470 | 1,284 | 2.31 |
| **Jun-22** | 12 | 68 | 40 | 97 | 0.29 | 0.19 | 70 | 42 | 94 | 0.19 | 84 | 50 | 114 | 0.23 |
| **Jul-22** | 99 | 573 | 301 | 897 | 0.10 | 1.59 | 638 | 355 | 1,048 | 1.77 | 771 | 430 | 1,266 | 2.14 |
| **Aug-22** | 39 | 223 | 97 | 366 | 0.16 | 0.62 | 245 | 125 | 429 | 0.68 | 297 | 152 | 519 | 0.83 |
| **Sep-22** | **163** | **931** | **674** | **1,171** | **0.08** | **2.59** | **1,067** | **803** | **1,382** | **2.96** | **1,286** | **970** | **1,659** | **3.57** |
| **Oct-22** | 1 | 6 | 1 | 17 | 1.00 | 0.02 | 6 | 1 | 18 | 0.02 | 8 | 1 | 22 | 0.02 |
| **Nov-22** | 6 | 35 | 6 | 76 | 0.41 | 0.10 | 78 | 49 | 168 | 0.22 | 95 | 59 | 203 | 0.26 |
| **Dec-22** | 8 | 46 | 12 | 87 | 0.35 | 0.13 | 56 | 22 | 99 | 0.16 | 68 | 26 | 120 | 0.19 |
| **Jan-23** | 11 | 63 | 11 | 132 | 0.30 | 0.18 | 65 | 13 | 132 | 0.18 | 78 | 15 | 160 | 0.22 |
| **Feb-23** | 34 | 194 | 91 | 308 | 0.17 | 0.54 | 207 | 105 | 350 | 0.57 | 249 | 127 | 420 | 0.69 |
| **Mar-23** | 35 | 202 | 98 | 311 | 0.17 | 0.56 | 219 | 102 | 367 | 0.61 | 261 | 122 | 435 | 0.73 |
| **Apr-23** | 77 | 431 | 90 | 874 | 0.11 | 1.20 | 455 | 107 | 1,024 | 1.26 | 545 | 128 | 1,223 | 1.51 |
| **c) Caledonia South Survey Area** | | | | | | | | | | | | | | |
| **May-21** | 99 | 574 | 342 | 812 | 0.10 | 1.08 | 621 | 348 | 921 | 1.16 | 751 | 421 | 1,115 | 1.41 |
| **Jun-21** | 131 | 761 | 384 | 1,273 | 0.09 | 1.43 | 1,091 | 447 | 1,990 | 2.04 | 1,312 | 540 | 2,389 | 2.46 |
| **Jul-21** | **244** | **1,465** | **895** | **2,210** | **0.06** | **2.75** | **1,530** | **960** | **2,320** | **2.87** | **1,853** | **1,163** | **2,809** | **3.47** |
| **Aug-21** | 26 | 150 | 69 | 224 | 0.20 | 0.28 | 743 | 218 | 1,345 | 1.39 | 899 | 264 | 1,629 | 1.69 |
| **Sep-21** | 67 | 389 | 238 | 575 | 0.12 | 0.73 | 457 | 278 | 689 | 0.86 | 552 | 337 | 830 | 1.03 |
| **Oct-21** | 10 | 58 | 35 | 81 | 0.32 | 0.11 | 73 | 41 | 105 | 0.14 | 88 | 50 | 128 | 0.16 |
| **Dec-21** | 5 | 29 | 12 | 46 | 0.45 | 0.05 | 258 | 176 | 316 | 0.48 | 312 | 213 | 383 | 0.58 |
| **Jan-22** | 7 | 40 | 12 | 69 | 0.38 | 0.07 | 52 | 16 | 98 | 0.10 | 64 | 19 | 119 | 0.12 |
| **Feb-22** | 27 | 147 | 92 | 206 | 0.19 | 0.28 | 277 | 183 | 373 | 0.52 | 335 | 222 | 452 | 0.63 |
| **Mar-22** | 6 | 32 | 6 | 64 | 0.41 | 0.06 | 51 | 11 | 121 | 0.10 | 60 | 13 | 143 | 0.11 |
| **Apr-22** | 100 | 573 | 344 | 831 | 0.10 | 1.07 | 699 | 360 | 1,088 | 1.31 | 838 | 434 | 1,301 | 1.57 |

| Survey | Raw count | Total unapportioned | | | | | Total apportioned | | | | Total apportioned and bias-corrected | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Abundance | LCL | UCL | Precision (CV) | Density ($km^2$) | Abundance | LCL | UCL | Density ($km^2$) | Abundance | LCL | UCL | Density ($km^2$) |
| **May-22** | 185 | 1,063 | 644 | 1,529 | 0.07 | 1.99 | 1,166 | 653 | 1,728 | 2.18 | 1,408 | 790 | 2,082 | 2.64 |
| **Jun-22** | 21 | 122 | 75 | 174 | 0.22 | 0.23 | 125 | 76 | 180 | 0.23 | 152 | 92 | 219 | 0.28 |
| **Jul-22** | 158 | 915 | 533 | 1,471 | 0.08 | 1.72 | 992 | 559 | 1,550 | 1.86 | 1,199 | 677 | 1,871 | 2.25 |
| **Aug-22** | 47 | 269 | 109 | 476 | 0.15 | 0.50 | 303 | 111 | 519 | 0.57 | 367 | 135 | 629 | 0.69 |
| **Sep-22** | **243** | **1,418** | **1,120** | **1,786** | **0.06** | **2.66** | **1,586** | **1,254** | **1,983** | **2.97** | **1,915** | **1,517** | **2,384** | **3.59** |
| **Oct-22** | 1 | 6 | 1 | 18 | 1.00 | 0.01 | 6 | 1 | 19 | 0.01 | 8 | 1 | 23 | 0.01 |
| **Nov-22** | 13 | 76 | 18 | 146 | 0.28 | 0.14 | 159 | 54 | 274 | 0.30 | 192 | 65 | 332 | 0.36 |
| **Dec-22** | 10 | 59 | 24 | 100 | 0.32 | 0.11 | 70 | 28 | 120 | 0.13 | 85 | 34 | 146 | 0.16 |
| **Jan-23** | 14 | 82 | 29 | 152 | 0.27 | 0.15 | 84 | 29 | 152 | 0.16 | 102 | 35 | 184 | 0.19 |
| **Feb-23** | 54 | 312 | 179 | 444 | 0.14 | 0.58 | 337 | 190 | 512 | 0.63 | 405 | 230 | 614 | 0.76 |
| **Mar-23** | 57 | 332 | 221 | 449 | 0.13 | 0.62 | 360 | 185 | 534 | 0.67 | 425 | 222 | 627 | 0.8 |
| **Apr-23** | 92 | 527 | 155 | 1,059 | 0.10 | 0.99 | 555 | 150 | 1,121 | 1.04 | 661 | 179 | 1,328 | 1.24 |

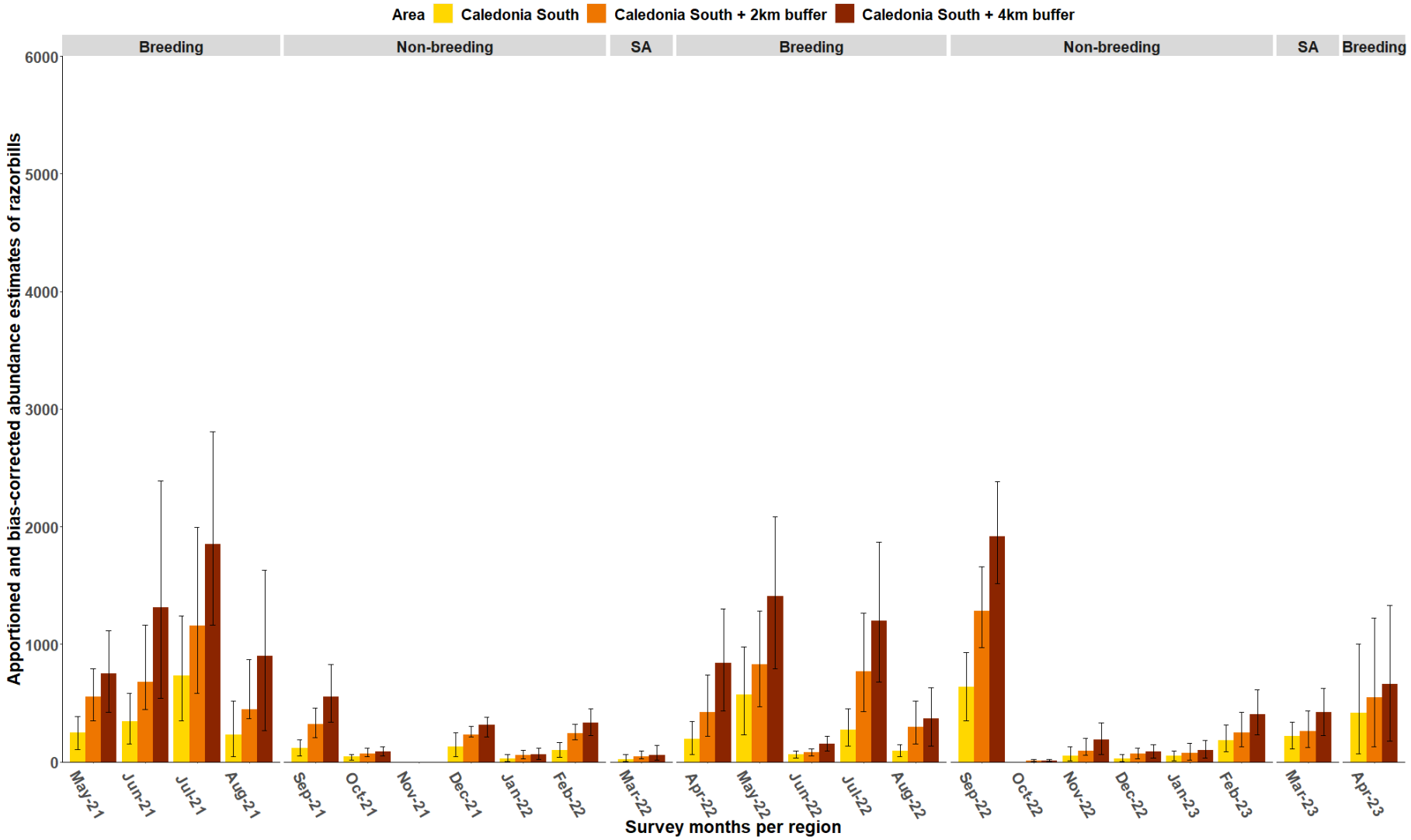



**Figure 26 Bar plot of the monthly apportioned abundances estimates (with 95% confidence intervals) of total razorbills recorded in each reporting region of Caledonia South Survey Area, during the May 2021 to April 2023 survey period. Razorbill seasonal periods are also displayed. SA stands for breeding site attendance.**

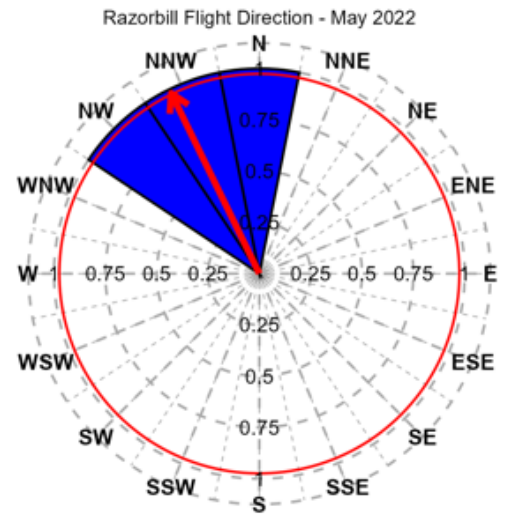
### *ii. Distribution and behaviour*

Maps of distribution are shown in Appendix 4: Figures A4.127-149. Razorbills were recorded throughout the Survey Area without any discernible distribution pattern in July to September and December 2021, March to April, June, August, November, and December 2022, and in January and March 2023 (Figures A4.129-131, 133, 136-137, 139, 141, 144-146, 148). During May and June 2021, razorbills occurred throughout the majority of the Survey Area with lower numbers towards the northeast and highest numbers in the northwest and south (Figures A4.127-128). Razorbills appeared exclusively in Caledonia South and its Buffer Zone in October 2021, and also displayed higher numbers therein during January, February and July 2022, and in February and April 2023 (Figures A4.132, 134-135, 140, 147, 149). In contrast, May and September 2022 recorded the majority of birds in Caledonia North (Figure A4.138, 142). Higher numbers of razorbills to the south (and to a lesser extent in the northwest) of the Survey Area indicate connectivity of these areas to breeding colonies within foraging range of these areas (East Caithness Cliffs SPA to the west of the Survey Area, and Troup, Pennan and Lion's Heads SPA to the south of the Survey Area).

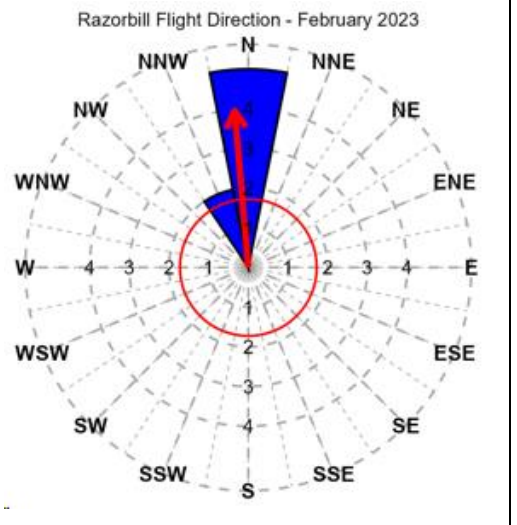
Significant predominant direction of flight was recorded in:

- **May**
  - 2022 north-northwest (Figure 27a)
- **February**
  - 2023 north (Figure 27b)
- **March**
  - 2023 east-southeast (Figure 27c)

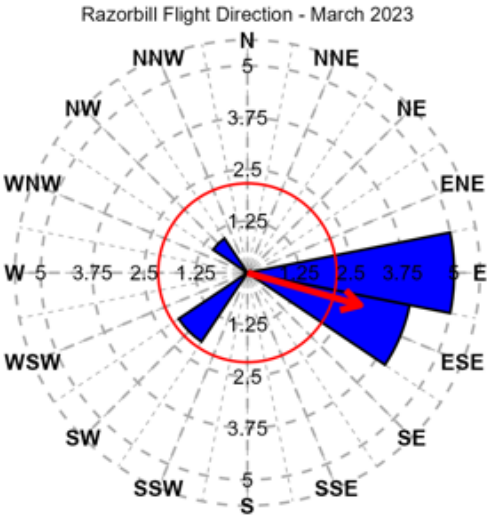
As very few birds were recorded in other surveys, they were too infrequent to determine any preference in flight direction (Appendix 5, Figure A5.18).




| | |
|---|---|
| Number of Observations | 3 |
| Mean Vector (μ) | 334.718 |
| Length of Mean Vector (r) | 0.979 |
| Rayleigh Test (Z) | 2.874 |
| Rayleigh Test (p) | 0.041 |
| **a May 2022** | |




| | |
|---|---|
| Number of Observations | 7 |
| Mean Vector (μ) | 355.524 |
| Length of Mean Vector (r) | 0.991 |
| Rayleigh Test (Z) | 6.868 |
| Rayleigh Test (p) | <0.001 |
| **b February 2023** | |




| | |
|---|---|
| Number of Observations | 12 |
| Mean Vector (μ) | 106.401 |
| Length of Mean Vector (r) | 0.567 |
| Rayleigh Test (Z) | 3.861 |
| Rayleigh Test (p) | 0.018 |
| **c March 2023** | |

**Figure 27 Summary of flight direction of razorbills within surveys where a significant flight direction was recorded during the May 2021 to April 2023 survey period**

## 4.20 Guillemot and / or razorbill

### *i. Abundance and density estimates*

#### *Caledonia OWF*

A total of 2,996 unidentified guillemots and / or razorbills were recorded in the Survey Area during both years of baseline surveys (Table 8). Guillemots and / or razorbills were recorded in every survey (Table 8). Guillemots and / or razorbills have been used for apportioning to species level where possible.

**Highest abundances were recorded during the breeding season, especially from May to July, with a peak of abundance in May 2022 (**

Table 71):

- 155 individuals were recorded in Caledonia OWF, resulting in an unapportioned mean abundance estimate of 898 [562; 1,338] individuals. This equated to a mean density estimate of 2.1 birds/km$^2$.
- 235 individuals were recorded in Caledonia OWF plus 2 km buffer, resulting in an unapportioned mean abundance estimate of 1,344 [881; 1,819] individuals. This equated to a mean density estimate of 2.09 birds/km$^2$.
- 312 individuals were recorded in the Survey Area, resulting in an unapportioned mean abundance estimate of 1,812 [1,126; 2,514] individuals. This equated to a mean density estimate of 2.05 birds/km$^2$.

**Table 71** **Raw counts, unapportioned abundance and density estimates (birds per km$^2$) of guillemots and / or razorbills in Caledonia OWF, Caledonia OWF plus 2 km buffer and the Survey Area during the May 2021 to April 2023 survey period**

| Survey | Raw count | Total unapportioned | | | | |
|---|---|---|---|---|---|---|
| | | Abundance | LCL | UCL | Precision (CV) | Density (km$^2$) |
| **a) Caledonia OWF** | | | | | | |
| **May-21** | 64 | 373 | 163 | 653 | 0.13 | 0.87 |
| **Jun-21** | 117 | 687 | 429 | 1,045 | 0.09 | 1.61 |
| **Jul-21** | 28 | 165 | 65 | 283 | 0.19 | 0.39 |
| **Aug-21** | 72 | 417 | 150 | 828 | 0.12 | 0.98 |
| **Sep-21** | 70 | 406 | 278 | 551 | 0.12 | 0.95 |
| **Oct-21** | 27 | 158 | 76 | 252 | 0.19 | 0.37 |
| **Nov-21** | 22 | 128 | 64 | 192 | 0.21 | 0.3 |
| **Dec-21** | 73 | 424 | 273 | 592 | 0.12 | 0.99 |
| **Jan-22** | 21 | 122 | 75 | 174 | 0.22 | 0.29 |
| **Feb-22** | 103 | 556 | 405 | 708 | 0.10 | 1.30 |
| **Mar-22** | 26 | 139 | 102 | 177 | 0.20 | 0.33 |
| **Apr-22** | 24 | 138 | 81 | 201 | 0.20 | 0.32 |
| **May-22** | 155 | 898 | 562 | 1,338 | 0.08 | 2.1 |
| **Jun-22** | 24 | 138 | 52 | 253 | 0.20 | 0.32 |
| **Jul-22** | 80 | 468 | 187 | 836 | 0.11 | 1.1 |
| **Aug-22** | 10 | 58 | 17 | 110 | 0.32 | 0.14 |
| **Sep-22** | 107 | 619 | 440 | 781 | 0.10 | 1.45 |
| **Oct-22** | 30 | 175 | 30 | 484 | 0.18 | 0.41 |
| **Nov-22** | 21 | 123 | 41 | 223 | 0.22 | 0.29 |
| **Dec-22** | 11 | 64 | 35 | 105 | 0.30 | 0.15 |
| **Jan-23** | 4 | 23 | 4 | 52 | 0.50 | 0.05 |
| **Feb-23** | 22 | 126 | 63 | 207 | 0.21 | 0.29 |
| **Mar-23** | 23 | 134 | 70 | 193 | 0.21 | 0.31 |
| **Apr-23** | 20 | 113 | 20 | 289 | 0.22 | 0.26 |
| **b) Caledonia OWF plus 2 km buffer** | | | | | | |
| **May-21** | 129 | 741 | 373 | 1,270 | 0.09 | 1.15 |
| **Jun-21** | 243 | 1,409 | 777 | 2,355 | 0.06 | 2.19 |
| **Jul-21** | 53 | 307 | 139 | 533 | 0.14 | 0.48 |
| **Aug-21** | 146 | 833 | 377 | 1,581 | 0.08 | 1.29 |
| **Sep-21** | 112 | 643 | 477 | 827 | 0.09 | 1.00 |
| **Oct-21** | 50 | 288 | 133 | 455 | 0.14 | 0.45 |
| **Nov-21** | 25 | 143 | 63 | 234 | 0.20 | 0.22 |
| **Dec-21** | 132 | 756 | 578 | 950 | 0.09 | 1.17 |
| **Jan-22** | 26 | 149 | 74 | 234 | 0.20 | 0.23 |
| **Feb-22** | 163 | 874 | 713 | 1,029 | 0.08 | 1.36 |
| **Mar-22** | 37 | 196 | 133 | 260 | 0.16 | 0.30 |
| **Apr-22** | 38 | 216 | 96 | 352 | 0.16 | 0.34 |
| **May-22** | 235 | 1,344 | 881 | 1,819 | 0.07 | 2.09 |
| **Jun-22** | 36 | 206 | 97 | 350 | 0.17 | 0.32 |
| **Jul-22** | 156 | 898 | 512 | 1,347 | 0.08 | 1.40 |
| **Aug-22** | 22 | 126 | 51 | 212 | 0.21 | 0.20 |
| **Sep-22** | 175 | 1,010 | 727 | 1,327 | 0.08 | 1.57 |
| **Oct-22** | 63 | 367 | 63 | 804 | 0.13 | 0.57 |
| **Nov-22** | 24 | 139 | 52 | 238 | 0.20 | 0.22 |
| **Dec-22** | 13 | 76 | 35 | 134 | 0.28 | 0.12 |

| Survey | Raw count | Total unapportioned | | | | |
|---|---|---|---|---|---|---|
| | | Abundance | LCL | UCL | Precision (CV) | Density (km²) |
| **Jan-23** | 5 | 29 | 6 | 52 | 0.45 | 0.05 |
| **Feb-23** | 26 | 149 | 80 | 246 | 0.20 | 0.23 |
| **Mar-23** | 38 | 220 | 139 | 295 | 0.16 | 0.34 |
| **Apr-23** | 25 | 142 | 40 | 312 | 0.20 | 0.22 |
| **c) Survey Area** | | | | | | |
| **May-21** | 172 | 1,005 | 555 | 1,601 | 0.08 | 1.14 |
| **Jun-21** | 401 | 2,359 | 1,230 | 3,648 | 0.05 | 2.67 |
| **Jul-21** | 77 | 465 | 235 | 755 | 0.11 | 0.53 |
| **Aug-21** | 401 | 2,326 | 934 | 4,073 | 0.05 | 2.63 |
| **Sep-21** | 174 | 1,018 | 650 | 1,516 | 0.08 | 1.15 |
| **Oct-21** | 78 | 457 | 205 | 749 | 0.11 | 0.52 |
| **Nov-21** | 33 | 192 | 81 | 314 | 0.17 | 0.22 |
| **Dec-21** | 208 | 1,212 | 897 | 1,532 | 0.07 | 1.37 |
| **Jan-22** | 35 | 203 | 122 | 290 | 0.17 | 0.23 |
| **Feb-22** | 212 | 1,164 | 845 | 1,444 | 0.07 | 1.32 |
| **Mar-22** | 55 | 297 | 189 | 421 | 0.13 | 0.34 |
| **Apr-22** | 50 | 288 | 121 | 473 | 0.14 | 0.33 |
| **May-22** | 312 | 1,812 | 1,126 | 2,514 | 0.06 | 2.05 |
| **Jun-22** | 48 | 278 | 133 | 434 | 0.14 | 0.31 |
| **Jul-22** | 224 | 1,309 | 719 | 1,975 | 0.07 | 1.48 |
| **Aug-22** | 38 | 218 | 126 | 322 | 0.16 | 0.25 |
| **Sep-22** | 232 | 1,354 | 975 | 1,745 | 0.07 | 1.53 |
| **Oct-22** | 83 | 488 | 112 | 976 | 0.11 | 0.55 |
| **Nov-22** | 30 | 177 | 88 | 259 | 0.18 | 0.20 |
| **Dec-22** | 17 | 100 | 53 | 159 | 0.24 | 0.11 |
| **Jan-23** | 6 | 35 | 12 | 65 | 0.41 | 0.04 |
| **Feb-23** | 36 | 208 | 110 | 330 | 0.17 | 0.24 |
| **Mar-23** | 44 | 258 | 164 | 341 | 0.15 | 0.29 |
| **Apr-23** | 27 | 155 | 46 | 339 | 0.19 | 0.18 |

### *Caledonia North*

A total of 2,996 unidentified guillemots and / or razorbills were recorded in the Survey Area during both years of baseline surveys (Table 9). Guillemots and / or razorbills were recorded in every survey (Table 9). Guillemot and / or razorbills have been used for apportioning to species level where possible.

**Highest abundances were recorded during the breeding season, especially from May to July, with a peak of abundance in May 2022 (**

Table 71):

- 83 individuals were recorded in Caledonia North, resulting in an unapportioned mean abundance estimate of 482 [174; 836] individuals. This equated to a mean density estimate of 2.21 birds/km$^2$.
- 156 individuals were recorded in Caledonia North plus 2 km buffer, resulting in an unapportioned mean abundance estimate of 888 [569; 1,236] individuals. This equated to a mean density estimate of 2.37 birds/km$^2$.
- 217 individuals were recorded in Caledonia North Survey Area, resulting in an unapportioned mean abundance estimate of 1,262 [762; 1,756] individuals. This equated to a mean density estimate of 2.27 birds/km$^2$.

**Table 72** **Raw counts, unapportioned abundance and density estimates (birds per km$^2$) of guillemots and / or razorbills in Caledonia North, Caledonia North plus 2 km buffer and Caledonia North Survey Area during the May 2021 to April 2023 survey period**

| Survey | Raw count | Total unapportioned | | | | |
|---|---|---|---|---|---|---|
| | | Abundance | LCL | UCL | Precision (CV) | Density (km$^2$) |
| **a) Caledonia North** | | | | | | |
| **May-21** | 24 | 140 | 70 | 204 | 0.20 | 0.64 |
| **Jun-21** | 31 | 183 | 130 | 231 | 0.18 | 0.84 |
| **Jul-21** | 7 | 41 | 12 | 71 | 0.38 | 0.19 |
| **Aug-21** | 15 | 87 | 35 | 139 | 0.26 | 0.40 |
| **Sep-21** | 24 | 139 | 58 | 220 | 0.20 | 0.64 |
| **Oct-21** | 12 | 70 | 18 | 134 | 0.29 | 0.32 |
| **Nov-21** | 11 | 64 | 12 | 129 | 0.30 | 0.29 |
| **Dec-21** | 26 | 151 | 58 | 278 | 0.20 | 0.69 |
| **Jan-22** | 8 | 46 | 8 | 98 | 0.35 | 0.21 |
| **Feb-22** | 52 | 280 | 113 | 431 | 0.14 | 1.28 |
| **Mar-22** | 9 | 48 | 11 | 91 | 0.33 | 0.22 |
| **Apr-22** | 6 | 34 | 6 | 75 | 0.41 | 0.16 |
| **May-22** | 83 | 482 | 174 | 836 | 0.11 | 2.21 |
| **Jun-22** | 6 | 34 | 6 | 91 | 0.41 | 0.16 |
| **Jul-22** | 28 | 164 | 53 | 299 | 0.19 | 0.75 |
| **Aug-22** | 4 | 23 | 12 | 35 | 0.50 | 0.11 |
| **Sep-22** | 52 | 298 | 143 | 448 | 0.14 | 1.36 |
| **Oct-22** | 1 | 6 | 1 | 17 | 1.00 | 0.03 |
| **Nov-22** | 14 | 83 | 18 | 165 | 0.27 | 0.38 |
| **Dec-22** | 5 | 29 | 5 | 76 | 0.45 | 0.13 |
| **Jan-23** | 2 | 12 | 2 | 35 | 0.71 | 0.05 |
| **Feb-23** | 8 | 46 | 12 | 86 | 0.35 | 0.21 |
| **Mar-23** | 14 | 82 | 47 | 111 | 0.27 | 0.38 |
| **Apr-23** | 5 | 28 | 6 | 56 | 0.45 | 0.13 |
| **b) Caledonia North plus 2 km buffer** | | | | | | |
| **May-21** | 41 | 235 | 154 | 315 | 0.16 | 0.63 |
| **Jun-21** | 48 | 278 | 185 | 359 | 0.14 | 0.74 |
| **Jul-21** | 11 | 63 | 29 | 98 | 0.30 | 0.17 |
| **Aug-21** | 25 | 142 | 62 | 233 | 0.20 | 0.38 |
| **Sep-21** | 46 | 262 | 165 | 381 | 0.15 | 0.70 |
| **Oct-21** | 13 | 74 | 23 | 143 | 0.28 | 0.20 |
| **Nov-21** | 13 | 74 | 23 | 137 | 0.28 | 0.20 |
| **Dec-21** | 53 | 301 | 176 | 466 | 0.14 | 0.80 |
| **Jan-22** | 12 | 68 | 12 | 136 | 0.29 | 0.18 |
| **Feb-22** | 84 | 451 | 247 | 660 | 0.11 | 1.20 |
| **Mar-22** | 13 | 69 | 21 | 122 | 0.28 | 0.18 |
| **Apr-22** | 14 | 79 | 17 | 140 | 0.27 | 0.21 |
| **May-22** | 156 | 888 | 569 | 1,236 | 0.08 | 2.37 |
| **Jun-22** | 14 | 81 | 29 | 138 | 0.27 | 0.22 |
| **Jul-22** | 44 | 252 | 120 | 418 | 0.15 | 0.67 |
| **Aug-22** | 13 | 74 | 17 | 149 | 0.28 | 0.20 |
| **Sep-22** | 74 | 430 | 192 | 668 | 0.12 | 1.15 |
| **Oct-22** | 30 | 176 | 30 | 482 | 0.18 | 0.47 |
| **Nov-22** | 19 | 110 | 35 | 196 | 0.23 | 0.29 |
| **Dec-22** | 8 | 47 | 18 | 94 | 0.35 | 0.13 |
| **Jan-23** | 3 | 18 | 3 | 41 | 0.58 | 0.05 |
| **Feb-23** | 10 | 57 | 17 | 108 | 0.32 | 0.15 |

| Survey | Raw count | Total unapportioned | | | | |
|---|---|---|---|---|---|---|
| | | Abundance | LCL | UCL | Precision (CV) | Density (km²) |
| **Mar-23** | 24 | 139 | 81 | 197 | 0.20 | 0.37 |
| **Apr-23** | 8 | 46 | 23 | 69 | 0.35 | 0.12 |
| **c) Caledonia North Survey Area** | | | | | | |
| **May-21** | 68 | 398 | 269 | 527 | 0.12 | 0.71 |
| **Jun-21** | 74 | 438 | 266 | 603 | 0.12 | 0.79 |
| **Jul-21** | 31 | 188 | 85 | 333 | 0.18 | 0.34 |
| **Aug-21** | 44 | 255 | 151 | 360 | 0.15 | 0.46 |
| **Sep-21** | 66 | 385 | 210 | 590 | 0.12 | 0.69 |
| **Oct-21** | 26 | 152 | 58 | 263 | 0.20 | 0.27 |
| **Nov-21** | 19 | 111 | 53 | 187 | 0.23 | 0.20 |
| **Dec-21** | 85 | 495 | 291 | 751 | 0.11 | 0.89 |
| **Jan-22** | 19 | 110 | 35 | 185 | 0.23 | 0.20 |
| **Feb-22** | 112 | 616 | 325 | 897 | 0.09 | 1.11 |
| **Mar-22** | 28 | 151 | 76 | 254 | 0.19 | 0.27 |
| **Apr-22** | 16 | 92 | 29 | 167 | 0.25 | 0.17 |
| **May-22** | 217 | 1,262 | 762 | 1,756 | 0.07 | 2.27 |
| **Jun-22** | 32 | 185 | 75 | 306 | 0.18 | 0.33 |
| **Jul-22** | 63 | 369 | 211 | 550 | 0.13 | 0.66 |
| **Aug-22** | 24 | 137 | 46 | 235 | 0.20 | 0.25 |
| **Sep-22** | 91 | 530 | 256 | 850 | 0.10 | 0.95 |
| **Oct-22** | 49 | 288 | 49 | 675 | 0.14 | 0.52 |
| **Nov-22** | 22 | 130 | 53 | 218 | 0.21 | 0.23 |
| **Dec-22** | 12 | 71 | 29 | 118 | 0.29 | 0.13 |
| **Jan-23** | 4 | 24 | 4 | 47 | 0.50 | 0.04 |
| **Feb-23** | 23 | 133 | 46 | 225 | 0.21 | 0.24 |
| **Mar-23** | 29 | 170 | 100 | 241 | 0.19 | 0.31 |
| **Apr-23** | 9 | 52 | 23 | 80 | 0.33 | 0.09 |

### *Caledonia South*

A total of 2,261 unidentified guillemots and / or razorbills were recorded in the Survey Area during both years of baseline surveys (Table 10). Guillemots and / or razorbills were recorded in every survey (Table 10). Guillemot and / or razorbills have been used for apportioning to species level where possible.

Highest abundances were recorded during the breeding season, especially from May to July, with a peak of abundance in June 2021 (Table 73):

- 86 individuals were recorded in Caledonia South, resulting in an unapportioned mean abundance estimate of 500 [227; 855] individuals. This equated to a mean density estimate of 2.38 birds/km$^2$.
- 209 individuals were recorded in Caledonia South plus 2 km buffer, resulting in an unapportioned mean abundance estimate of 1,212 [534; 2,012] individuals. This equated to a mean density estimate of 3.37 birds/km$^2$.
- 354 individuals were recorded in Caledonia South Survey Area, resulting in an unapportioned mean abundance estimate of 2,058 [965; 3,482] individuals. This equated to a mean density estimate of 3.86 birds/km$^2$.

**Table 73** **Raw counts, unapportioned abundance and density estimates (birds per km$^2$) of guillemots and / or razorbills in Caledonia South, Caledonia South plus 2 km buffer and Caledonia South Survey Area during the May 2021 to April 2023 survey period**

| Survey | Raw count | Total unapportioned | | | | |
|---|---|---|---|---|---|---|
| | | Abundance | LCL | UCL | Precision (CV) | Density (km$^2$) |
| **a) Caledonia South** | | | | | | |
| **May-21** | 40 | 233 | 47 | 489 | 0.16 | 1.11 |
| **Jun-21** | 86 | 500 | 227 | 855 | 0.11 | 2.38 |
| **Jul-21** | 22 | 129 | 22 | 246 | 0.21 | 0.61 |
| **Aug-21** | 57 | 329 | 75 | 756 | 0.13 | 1.56 |
| **Sep-21** | 46 | 267 | 186 | 360 | 0.15 | 1.27 |
| **Oct-21** | 15 | 88 | 41 | 141 | 0.26 | 0.42 |
| **Nov-21** | 11 | 63 | 35 | 104 | 0.30 | 0.30 |
| **Dec-21** | 47 | 273 | 157 | 435 | 0.15 | 1.30 |
| **Jan-22** | 13 | 75 | 40 | 116 | 0.28 | 0.36 |
| **Feb-22** | 51 | 276 | 189 | 400 | 0.14 | 1.31 |
| **Mar-22** | 17 | 91 | 43 | 140 | 0.24 | 0.43 |
| **Apr-22** | 18 | 104 | 75 | 138 | 0.24 | 0.49 |
| **May-22** | 72 | 416 | 243 | 629 | 0.12 | 1.98 |
| **Jun-22** | 18 | 104 | 41 | 168 | 0.24 | 0.49 |
| **Jul-22** | 52 | 303 | 52 | 671 | 0.14 | 1.44 |
| **Aug-22** | 6 | 35 | 6 | 69 | 0.41 | 0.17 |
| **Sep-22** | 55 | 321 | 187 | 449 | 0.13 | 1.53 |
| **Oct-22** | 29 | 170 | 29 | 476 | 0.19 | 0.81 |
| **Nov-22** | 7 | 41 | 7 | 88 | 0.38 | 0.19 |
| **Dec-22** | 6 | 35 | 12 | 59 | 0.41 | 0.17 |
| **Jan-23** | 2 | 12 | 2 | 29 | 0.71 | 0.06 |
| **Feb-23** | 14 | 80 | 17 | 160 | 0.27 | 0.38 |
| **Mar-23** | 9 | 52 | 12 | 104 | 0.33 | 0.25 |
| **Apr-23** | 15 | 85 | 15 | 233 | 0.26 | 0.40 |
| **b) Caledonia South plus 2 km buffer** | | | | | | |
| **May-21** | 92 | 532 | 191 | 1,057 | 0.10 | 1.48 |
| **Jun-21** | 209 | 1,212 | 534 | 2,012 | 0.07 | 3.37 |
| **Jul-21** | 45 | 262 | 81 | 500 | 0.15 | 0.73 |
| **Aug-21** | 128 | 734 | 287 | 1,496 | 0.09 | 2.04 |
| **Sep-21** | 81 | 468 | 324 | 647 | 0.11 | 1.30 |
| **Oct-21** | 39 | 226 | 104 | 360 | 0.16 | 0.63 |
| **Nov-21** | 14 | 80 | 40 | 137 | 0.27 | 0.22 |
| **Dec-21** | 90 | 519 | 363 | 686 | 0.11 | 1.44 |
| **Jan-22** | 19 | 109 | 46 | 184 | 0.23 | 0.30 |
| **Feb-22** | 89 | 475 | 342 | 620 | 0.11 | 1.32 |
| **Mar-22** | 29 | 153 | 101 | 201 | 0.19 | 0.43 |
| **Apr-22** | 30 | 172 | 80 | 269 | 0.18 | 0.48 |
| **May-22** | 94 | 539 | 316 | 820 | 0.10 | 1.50 |
| **Jun-22** | 24 | 136 | 68 | 216 | 0.20 | 0.38 |
| **Jul-22** | 119 | 689 | 249 | 1,180 | 0.09 | 1.92 |
| **Aug-22** | 10 | 57 | 23 | 97 | 0.32 | 0.16 |
| **Sep-22** | 120 | 685 | 491 | 880 | 0.09 | 1.91 |
| **Oct-22** | 56 | 323 | 56 | 708 | 0.13 | 0.90 |
| **Nov-22** | 10 | 58 | 17 | 111 | 0.32 | 0.16 |
| **Dec-22** | 9 | 52 | 35 | 69 | 0.33 | 0.14 |
| **Jan-23** | 3 | 17 | 6 | 34 | 0.58 | 0.05 |
| **Feb-23** | 19 | 108 | 40 | 200 | 0.23 | 0.30 |

| Survey | Raw count | Total unapportioned | | | | |
|---|---|---|---|---|---|---|
| | | Abundance | LCL | UCL | Precision (CV) | Density (km²) |
| **Mar-23** | 22 | 127 | 75 | 190 | 0.21 | 0.35 |
| **Apr-23** | 18 | 101 | 18 | 252 | 0.24 | 0.28 |
| **c) Caledonia South Survey Area** | | | | | | |
| **May-21** | 125 | 725 | 319 | 1,300 | 0.09 | 1.36 |
| **Jun-21** | 354 | 2,058 | 965 | 3,482 | 0.05 | 3.86 |
| **Jul-21** | 59 | 354 | 150 | 619 | 0.13 | 0.66 |
| **Aug-21** | 376 | 2,163 | 742 | 3,779 | 0.05 | 4.06 |
| **Sep-21** | 136 | 790 | 476 | 1,254 | 0.09 | 1.48 |
| **Oct-21** | 71 | 412 | 180 | 697 | 0.12 | 0.77 |
| **Nov-21** | 27 | 155 | 92 | 241 | 0.19 | 0.29 |
| **Dec-21** | 150 | 868 | 642 | 1,099 | 0.08 | 1.63 |
| **Jan-22** | 25 | 144 | 81 | 225 | 0.20 | 0.27 |
| **Feb-22** | 121 | 657 | 445 | 858 | 0.09 | 1.23 |
| **Mar-22** | 38 | 204 | 140 | 274 | 0.16 | 0.38 |
| **Apr-22** | 45 | 258 | 109 | 407 | 0.15 | 0.48 |
| **May-22** | 151 | 868 | 500 | 1,305 | 0.08 | 1.63 |
| **Jun-22** | 34 | 197 | 87 | 324 | 0.17 | 0.37 |
| **Jul-22** | 183 | 1,060 | 463 | 1,737 | 0.07 | 1.99 |
| **Aug-22** | 20 | 115 | 46 | 201 | 0.22 | 0.22 |
| **Sep-22** | 170 | 992 | 683 | 1,278 | 0.08 | 1.86 |
| **Oct-22** | 57 | 335 | 57 | 758 | 0.13 | 0.63 |
| **Nov-22** | 26 | 152 | 82 | 234 | 0.20 | 0.28 |
| **Dec-22** | 11 | 65 | 41 | 94 | 0.30 | 0.12 |
| **Jan-23** | 4 | 23 | 6 | 41 | 0.50 | 0.04 |
| **Feb-23** | 28 | 162 | 87 | 265 | 0.19 | 0.30 |
| **Mar-23** | 29 | 169 | 93 | 245 | 0.19 | 0.32 |
| **Apr-23** | 21 | 120 | 29 | 280 | 0.22 | 0.22 |

### *ii. Distribution and behaviour*

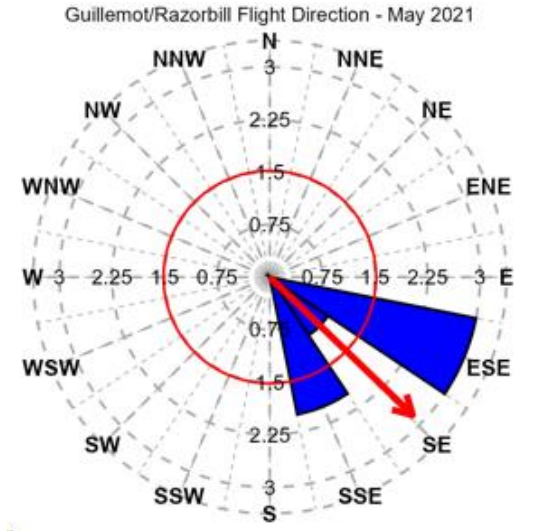
Maps of distribution are shown in Appendix 4: Figures A4.150-173. Guillemot and / or razorbills were distributed throughout the Survey Area with highest numbers in Caledonia South and its Buffer Zone during June to December 2021, March, April and July 2022 (Figure A4.151-157, 160-161, 164). During the remaining months of the survey period, guillemot and / or razorbills were loosely distributed throughout the Survey Area (Figures A4.150, 158-159, 162-163, 165-173).

Significant predominant direction of flight was recorded in:

- **May**
  - 2021 southeast (Figure 28a)
- **June**
  - 2021 east (Figure 28b)
- **October**
  - 2021 south (Figure 28c)
  - 2022 south (Figure 28f)
- **December**
  - 2021 northwest (Figure 28d)
- **January**
  - 2022 south (Figure 28e)
- **February**
  - 2023 northwest (Figure 28g)

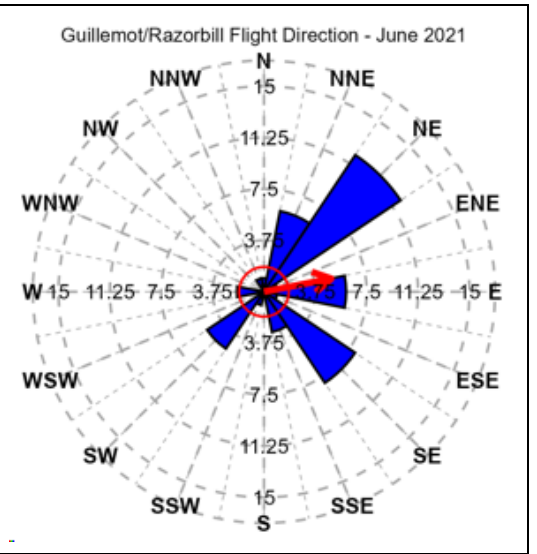
- **March**
  - 2022 west-southwest (Figure 28h)

As very few birds were recorded in flight in other surveys, they were too infrequent to determine any preference in flight direction (Appendix 5, Figure A5.19).



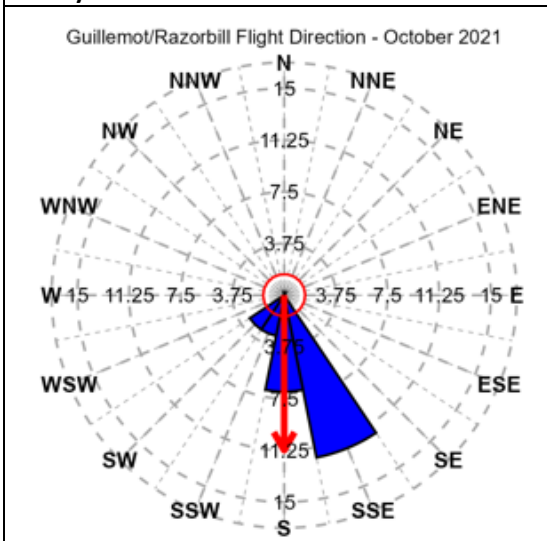

| | |
|---|---|
| Number of Observations | 6 |
| Mean Vector (μ) | 134.765 |
| Length of Mean Vector (r) | 0.943 |
| Rayleigh Test (Z) | 5.336 |
| Rayleigh Test (p) | <0.001 |

**a May 2021**



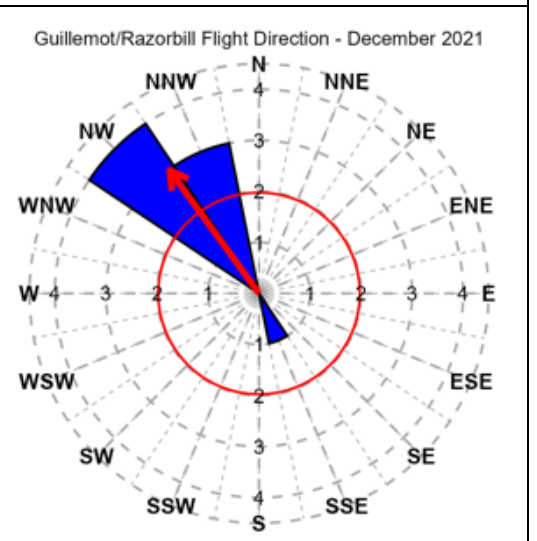

| | |
|---|---|
| Number of Observations | 47 |
| Mean Vector (μ) | 79.002 |
| Length of Mean Vector (r) | 0.417 |
| Rayleigh Test (Z) | 8.171 |
| Rayleigh Test (p) | <0.001 |

**b June 2021**



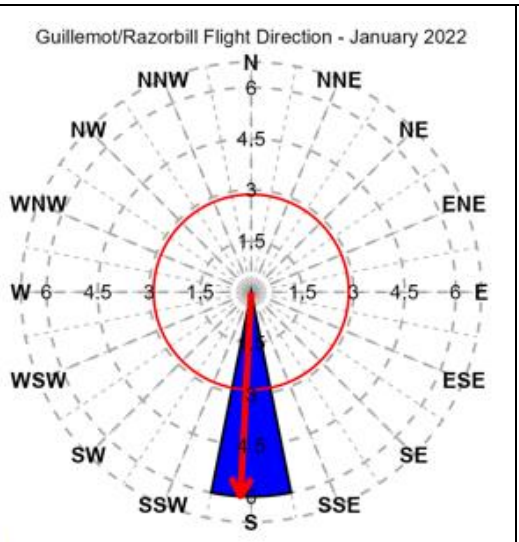

| | |
|---|---|
| Number of Observations | 25 |
| Mean Vector (μ) | 180.986 |
| Length of Mean Vector (r) | 0.936 |
| Rayleigh Test (Z) | 21.926 |
| Rayleigh Test (p) | <0.001 |

**c October 2021**



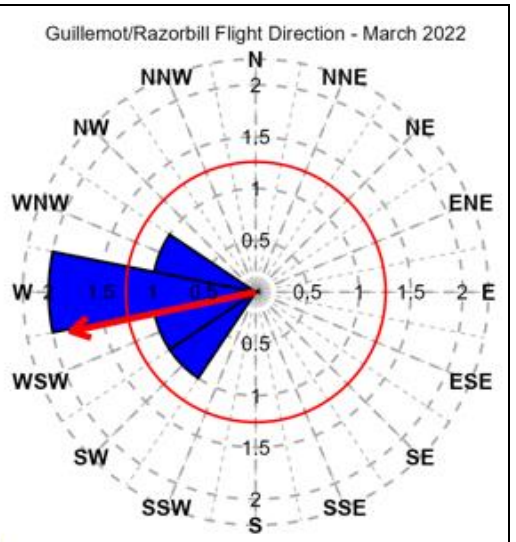

| | |
|---|---|
| Number of Observations | 8 |
| Mean Vector (μ) | 324.827 |
| Length of Mean Vector (r) | 0.744 |
| Rayleigh Test (Z) | 4.431 |
| Rayleigh Test (p) | 0.007 |

**d December 2021**



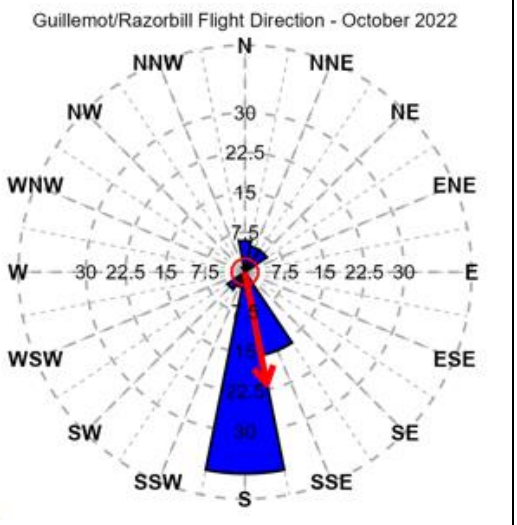

| | |
|---|---|
| Number of Observations | 6 |
| Mean Vector (μ) | 183.797 |
| Length of Mean Vector (r) | 0.999 |
| Rayleigh Test (Z) | 5.987 |
| Rayleigh Test (p) | <0.001 |

**e January 2022**



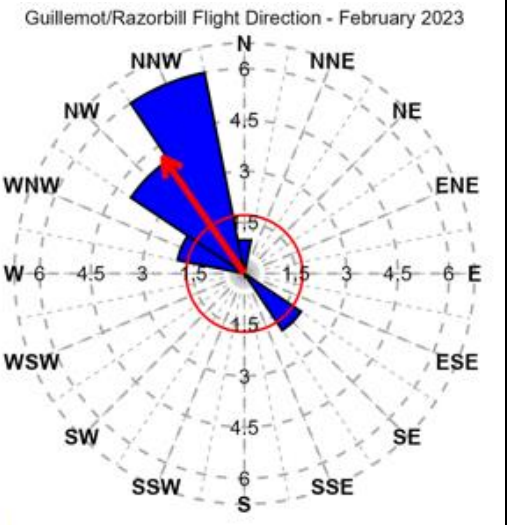

| | |
|---|---|
| Number of Observations | 5 |
| Mean Vector (μ) | 258.854 |
| Length Mean Vector (r) | 0.911 |
| Rayleigh Test (Z) | 4.145 |
| Rayleigh Test (p) | 0.008 |

**f March 2022**




| | |
|---|---|
| Number of Observations | 78 |
| Mean Vector (μ) | 169.596 |
| Length of Mean Vector (r) | 0.567 |
| Rayleigh Test (Z) | 25.034 |
| Rayleigh Test (p) | <0.001 |

**g October 2022**




| | |
|---|---|
| Number of Observations | 15 |
| Mean Vector (μ) | 325.430 |
| Length of Mean Vector (r) | 0.688 |
| Rayleigh Test (Z) | 7.102 |
| Rayleigh Test (p) | <0.001 |

**h February 2023**

**Figure 28 Summary of flight direction of guillemots and /or razorbills within surveys where a significant flight direction was recorded during the May 2021 to April 2023 survey period**

## 4.21 Black guillemot

### *i. Abundance and density estimates*

A total of four black guillemots were recorded in the Survey Area during both years of baseline surveys (Table 8), specifically in June 2021, April and June 2022. In these months, peak numbers were recorded in June 2022, with two individuals, resulting in an unapportioned and apportioned mean abundance of 12 [2; 29] individuals, which equated to a mean density estimate of 0.01 birds/km$^2$ (Table 74).

Measures of precisions were high, which was likely related to the low numbers of individuals recorded in each region (CV > 0.16; Table 74).

**Table 74 Raw counts, unapportioned and apportioned abundance and density estimates (birds per km$^2$) of black guillemots in Caledonia OWF, Caledonia OWF plus 2 km buffer and the Survey Area during the May 2021 to April 2023 survey period**

| Survey | Raw count | Total unapportioned | | | | | Total apportioned | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Abundance | LCL | UCL | Precision (CV) | Density (km$^2$) | Abundance | LCL | UCL | Density (km$^2$) |
| **a) Caledonia OWF** | | | | | | | | | | |
| **Jun-21** | 1 | 6 | 1 | 18 | 1.00 | 0.01 | 6 | 1 | 18 | 0.01 |
| **Jun-22** | 1 | 6 | 1 | 17 | 1.00 | 0.01 | 6 | 1 | 17 | 0.01 |
| **b) Caledonia OWF plus 2 km buffer** | | | | | | | | | | |
| **Jun-21** | 1 | 6 | 1 | 17 | 1.00 | 0.01 | 6 | 1 | 18 | 0.01 |
| **Apr-22** | 1 | 6 | 1 | 17 | 1.00 | 0.01 | 6 | 1 | 18 | 0.01 |
| **Jun-22** | 2 | 11 | 2 | 29 | 0.71 | 0.02 | 11 | 2 | 29 | 0.02 |
| **c) Survey Area** | | | | | | | | | | |
| **Jun-21** | 1 | 6 | 1 | 18 | 1.00 | 0.01 | 6 | 1 | 19 | 0.01 |
| **Apr-22** | 1 | 6 | 1 | 17 | 1.00 | 0.01 | 6 | 1 | 18 | 0.01 |
| **Jun-22** | 2 | 12 | 2 | 29 | 0.71 | 0.01 | 12 | 2 | 29 | 0.01 |

In Caledonia North Survey Area, an individual was recorded in both June 2021 and 2022, therefore, resulting in low abundance and density estimates (Table 75). Similarly, in Caledonia South Survey Area, a single individual was recorded in June 2022, April and June 2022, which therefore also resulted in low abundance and density estimates (Table 76).

Measures of precisions were high (indicating lower levels of precision), which is likely related to the low numbers of individuals recorded in each reporting region during each survey (CV > 0.16; Table 75 and Table 76).

**Table 75 Raw counts, unapportioned and apportioned abundance and density estimates (birds per km$^2$) of black guillemots in Caledonia North, Caledonia North plus 2 km buffer and Caledonia North Survey Area during the May 2021 to April 2023 survey period**

| Survey | Raw count | Total unapportioned | | | | | Total apportioned | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Abundance | LCL | UCL | Precision (CV) | Density (km$^2$) | Abundance | LCL | UCL | Density (km$^2$) |
| **a) Caledonia North** | | | | | | | | | | |
| **Jun-22** | 1 | 6 | 1 | 17 | 1.00 | 0.03 | 6 | 1 | 17 | 0.03 |
| **b) Caledonia North plus 2 km buffer** | | | | | | | | | | |
| **Jun-22** | 1 | 6 | 1 | 17 | 1.00 | 0.02 | 6 | 1 | 17 | 0.02 |
| **c) Caledonia North Survey Area** | | | | | | | | | | |
| **Jun-21** | 1 | 6 | 1 | 18 | 1.00 | 0.01 | 6 | 1 | 18 | 0.01 |
| **Jun-22** | 1 | 6 | 1 | 17 | 1.00 | 0.01 | 6 | 1 | 17 | 0.01 |

**Table 76 Raw counts, unapportioned and apportioned abundance and density estimates (birds per km$^2$) of black guillemots in Caledonia South, Caledonia South plus 2 km buffer and Caledonia South Survey Area during the May 2021 to April 2023 survey period**

| Survey | Raw count | Total unapportioned | | | | | Total apportioned | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Abundance | LCL | UCL | Precision (CV) | Density (km$^2$) | Abundance | LCL | UCL | Density (km$^2$) |
| **a) Caledonia South** | | | | | | | | | | |
| **Jun-21** | 1 | 6 | 1 | 17 | 1.00 | 0.03 | 6 | 1 | 17 | 0.03 |
| **b) Caledonia South plus 2 km buffer** | | | | | | | | | | |
| **Jun-21** | 1 | 6 | 1 | 17 | 1.00 | 0.02 | 6 | 1 | 18 | 0.02 |
| **Apr-22** | 1 | 6 | 1 | 17 | 1.00 | 0.02 | 6 | 1 | 18 | 0.02 |
| **Jun-22** | 1 | 6 | 1 | 17 | 1.00 | 0.02 | 6 | 1 | 17 | 0.02 |
| **c) Caledonia South Survey Area** | | | | | | | | | | |
| **Jun-21** | 1 | 6 | 1 | 17 | 1.00 | 0.01 | 6 | 1 | 18 | 0.01 |
| **Apr-22** | 1 | 6 | 1 | 17 | 1.00 | 0.01 | 6 | 1 | 18 | 0.01 |
| **Jun-22** | 1 | 6 | 1 | 17 | 1.00 | 0.01 | 6 | 1 | 17 | 0.01 |

#### *ii. Distribution and behaviour*

The single black guillemot recorded in June 2021 was located in the centre of Caledonia South (Appendix 4, Figure A4.174), while the individual recorded in April 2022 was recorded at the southern boundary of Caledonia South (Appendix 4, Figure A4.175). In June 2022, one individual was recorded in the north of Caledonia North while the other was recorded in the south of Caledonia South Buffer Zone (Appendix 4, Figure A4.176).

### 4.22 Puffin

#### *i. Abundance and density estimates*

##### *Caledonia OWF*

A total of 2,054 puffins were recorded in the Survey Area during both years of baseline surveys (Table 8). Puffins were recorded in every survey except November 2021 to February 2022 and November to December 2022 (Table 8). Puffins were the most abundant during the breeding season (April to mid-August, with birds attending colonies from mid-March onwards). Peak of abundance was recorded in August 2021 (Table 77, Figure 29):

- 370 individuals were recorded in Caledonia OWF, resulting in an unapportioned mean abundance estimate of 2,142 [1,042; 3,438], an apportioned mean abundance estimate of 2,390 [1,099; 3,951] and an apportioned and availability bias-corrected mean abundance estimate of 2,784 [1,280; 4,603] individuals. These equated to mean density estimates of 5.01 (unapportioned), 5.59 (apportioned) and 6.51 (apportioned and availability bias-corrected) birds/km$^2$.
- 462 individuals were recorded in Caledonia OWF plus 2 km buffer, resulting in an unapportioned mean abundance estimate of 2,636 [1,381; 4,246], an apportioned mean abundance estimate of 3,076 [1,539; 4,976] and an apportioned and availability bias-corrected mean abundance estimate of 3,583 [1,793; 5,797] individuals. These equated to mean density estimates of 4.10 (unapportioned), 4.78 (apportioned) and 5.56 (apportioned and availability bias-corrected) birds/km$^2$.
- 562 individuals were recorded in the Survey Area, resulting in an unapportioned mean abundance estimate of 3,260 [1,949; 4,891], an apportioned mean abundance estimate of 4,123 [2,188; 6,363] and an apportioned and availability bias-corrected mean abundance estimate of 4,803 [2,548; 7,413] individuals. These equated to mean density estimates of 3.69

(unapportioned), 4.66 (apportioned) and 5.43 (apportioned and availability bias-corrected) birds/km$^2$.

During the 2021 breeding season, mean apportioned and availability bias-corrected puffin abundances in the Survey Area and reporting regions between May and July were very consistent. In August 2021, a large peak in mean abundance was observed, which was also the peak breeding season abundance for all reporting regions across the baseline survey period. It is anticipated that rather than a peak of breeding adult birds, the timing of this peak, and the size of the abundances recorded relative to other breeding season surveys, may indicate a post-breeding peak of birds, likely originating from multiple breeding colonies across the wider region. What could be considered to be an equivalent peak occurred in September 2022 (i.e. outside the breeding season). During the 2022 breeding season, mean abundances were consistent across April and May (and higher than the corresponding abundances recorded in the same months in 2021. In June and July 2022, abundances were considerably lower, with higher abundances reported during August 2022. The reason for the different temporal patterns in the 2021 and 2022 breeding seasons is unclear.

Reductions in mean apportioned and availability bias-corrected abundance in the breeding season surveys outside the peak survey month varied from 70% to 99%, with most surveys falling somewhere in the middle of the two extremes of this range. This is indicative of the overall breeding season peak for being considerably higher than the abundance estimates recorded for all other surveys during this season. This is perhaps related to the presence of a post-breeding season peak in August 2021, which happened to fall inside the breeding season.

During the non-breeding season (September to mid-March), puffins were only recorded in September to October 2021, September 2022 and January to March 2023, with a peak in September 2022 (Table 77, Figure 29):

- 213 individuals were recorded in Caledonia OWF, resulting in an unapportioned mean abundance estimate of 1,233 [602; 1,921], an apportioned mean abundance estimate of 1,269 [627; 2,031] and an apportioned and availability bias-corrected mean abundance estimate of 1,477 [730; 2,360] individuals. These equated to mean density estimates of 2.89 (unapportioned), 2.97 (apportioned) and 3.45 (apportioned and availability bias-corrected) birds/km$^2$.
- 342 individuals were recorded in Caledonia OWF plus 2 km buffer, resulting in an unapportioned mean abundance estimate of 1,974 [1,281; 2,782], an apportioned mean abundance estimate of 2,084 [1,266; 2,990] and an apportioned and availability bias-corrected mean abundance estimate of 2,426 [1,475; 3,477] individuals. These equated to mean density estimates of 3.07 (unapportioned), 3.24 (apportioned) and 3.77 (apportioned and availability bias-corrected) birds/km$^2$.
- 495 individuals were recorded in the Survey Area, resulting in an unapportioned mean abundance estimate of 2,888 [1,727; 4,277], an apportioned mean abundance estimate of 3,001 [1,745; 4,345] and an apportioned and availability bias-corrected mean abundance estimate of 3,492 [2,032; 5,051] individuals. These equated to mean density estimates of 3.27 (unapportioned), 3.39 (apportioned) and 3.95 (apportioned and availability bias-corrected) birds/km$^2$.

During the two non-breeding seasons covered by the baseline surveys, peak mean apportioned and availability bias-corrected abundances occurred within the Survey Area and reporting regions in September 2022. The timing of this peak is indicative of a post-breeding season aggregation of birds (likely consisting of birds from multiple breeding colonies across the region). A peak abundance estimate in August 2021 (i.e. within the breeding season) is also considered likely to be a post-breeding aggregation of birds, which arguably could be considered a non-breeding count, despite the earlier timing in 2021. The September 2022 mean apportioned and availability bias-corrected abundances were considerably larger than in any other survey during the non-breeding season for this species

within the Survey Area and reporting regions. Puffin were absent from the surveys carried out between November 2021 and February 2022, and October to December 2022, in keeping with the general understand of the seasonal movements of this species. Reductions in mean apportioned and availability bias-corrected abundance relative to the peak were between 86% to >99.5%, reflecting the fact that the September 2022 peak was very large relative to the other mean apportioned and availability bias-corrected abundances recorded for puffin during the non-breeding season.

During the breeding site attendance period (March), puffins were recorded in low numbers, with peak numbers in March 2023 (Table 77, Figure 29):

- Nine individuals were recorded in Caledonia OWF, resulting in an unapportioned mean abundance estimate of 53 [18; 88], an apportioned mean abundance estimate of 54 [18; 95] and an apportioned and availability bias-corrected mean abundance estimate of 63 [21; 111] individuals. These equated to mean density estimates of 0.12 (unapportioned), 0.13 (apportioned) and 0.15 (apportioned and availability bias-corrected) birds/km$^2$.
- 11 individuals were recorded in Caledonia OWF plus 2 km buffer, resulting in an unapportioned mean abundance estimate of 64 [23; 110], an apportioned mean abundance estimate of 65 [17; 112] and an apportioned and availability bias-corrected mean abundance estimate of 75 [20; 131] individuals. These equated to mean density estimates of 0.10 (unapportioned), 0.10 (apportioned) and 0.12 (apportioned and availability bias-corrected) birds/km$^2$.
- 14 individuals were recorded in the Survey Area, resulting in an unapportioned mean abundance estimate of 82 [29; 141], an apportioned mean abundance estimate of 83 [35; 139] and an apportioned and availability bias-corrected mean abundance estimate of 97 [41; 161] individuals. These equated to mean density estimates of 0.09 (unapportioned), 0.09 (apportioned) and 0.11 (apportioned and availability bias-corrected) birds/km$^2$.

Measures of precisions were variable for puffin across the survey period (Table 77). During eight of 16 surveys in which the species was recorded within Caledonia OWF, CV values were ≤ 0.16, indicating higher levels of precision (Table 77). Seven of these eight surveys were within the breeding season, which meant that seven of 10 breeding season surveys had a CV value of ≤ 0.16 (Table 77). Higher levels of precision coincided with higher numbers of puffins being recorded (Table 77). Outside the breeding season, when lower numbers of puffins were recorded, CV values were typically calculated to be between 0.2 to 0.6, indicating lower levels of precision (Table 77). For Caledonia OWF plus buffer regions, CV values were generally lower than the corresponding CV values for Caledonia OWF, indicating higher precision within these reporting regions (Table 77).

**Table 77** **Raw counts, unapportioned, apportioned, and apportioned and availability bias-corrected abundance and density estimates (birds per km$^2$) of puffins in Caledonia OWF, Caledonia OWF plus 2 km buffer and the Survey Area during the May 2021 to April 2023 survey period. Colour gradients follow the ascending order of puffin raw counts per season, with light yellow to orange (peak number) for the breeding season months (April to mid-August) and light blue to royal blue (peak number) for the wintering months (September to mid-March). No colours were attributed to the breeding site attendance period (March)**

| Survey | Raw count | Total unapportioned | | | | | Total apportioned | | | | Total apportioned and bias-corrected | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Abundance | LCL | UCL | Precision (CV) | Density (km$^2$) | Abundance | LCL | UCL | Density (km$^2$) | Abundance | LCL | UCL | Density (km$^2$) |
| **a) Caledonia OWF** | | | | | | | | | | | | | | |
| **May-21** | 43 | 251 | 122 | 414 | 0.15 | 0.59 | 252 | 122 | 412 | 0.59 | 294 | 142 | 480 | 0.69 |
| **Jun-21** | 37 | 217 | 82 | 399 | 0.16 | 0.51 | 220 | 77 | 413 | 0.51 | 255 | 90 | 478 | 0.6 |
| **Jul-21** | 46 | 271 | 106 | 478 | 0.15 | 0.63 | 277 | 111 | 510 | 0.65 | 320 | 129 | 586 | 0.75 |
| **Aug-21** | 370 | 2,142 | 1,042 | 3,438 | 0.05 | 5.01 | 2,390 | 1,099 | 3,951 | 5.59 | 2,784 | 1,280 | 4,603 | 6.51 |
| **Sep-21** | 13 | 75 | 46 | 110 | 0.28 | 0.18 | 76 | 41 | 113 | 0.18 | 89 | 48 | 132 | 0.21 |
| **Oct-21** | 28 | 164 | 70 | 281 | 0.19 | 0.38 | 179 | 73 | 297 | 0.42 | 208 | 85 | 346 | 0.49 |
| **Apr-22** | 88 | 507 | 253 | 858 | 0.11 | 1.19 | 523 | 245 | 891 | 1.22 | 610 | 285 | 1,038 | 1.43 |
| **May-22** | 107 | 620 | 365 | 863 | 0.10 | 1.45 | 627 | 397 | 876 | 1.47 | 731 | 463 | 1,020 | 1.71 |
| **Jun-22** | 10 | 57 | 11 | 126 | 0.32 | 0.13 | 58 | 10 | 139 | 0.14 | 67 | 12 | 159 | 0.16 |
| **Jul-22** | 27 | 158 | 99 | 228 | 0.19 | 0.37 | 160 | 90 | 243 | 0.37 | 185 | 104 | 281 | 0.43 |
| **Aug-22** | 59 | 340 | 208 | 473 | 0.13 | 0.8 | 351 | 210 | 497 | 0.82 | 408 | 245 | 578 | 0.96 |
| **Sep-22** | 213 | 1,233 | 602 | 1,921 | 0.07 | 2.89 | 1,269 | 627 | 2,031 | 2.97 | 1,477 | 730 | 2,360 | 3.45 |
| **Jan-23** | 3 | 17 | 3 | 52 | 0.58 | 0.04 | 17 | 3 | 53 | 0.04 | 20 | 4 | 62 | 0.05 |
| **Feb-23** | 5 | 29 | 6 | 52 | 0.45 | 0.07 | 29 | 6 | 53 | 0.07 | 34 | 7 | 62 | 0.08 |
| **Mar-23** | 9 | 53 | 18 | 88 | 0.33 | 0.12 | 54 | 18 | 95 | 0.13 | 63 | 21 | 111 | 0.15 |
| **Apr-23** | 5 | 28 | 6 | 57 | 0.45 | 0.07 | 28 | 5 | 58 | 0.07 | 33 | 6 | 67 | 0.08 |
| **b) Caledonia OWF plus 2 km buffer** | | | | | | | | | | | | | | |
| **May-21** | 73 | 419 | 276 | 586 | 0.12 | 0.65 | 421 | 282 | 592 | 0.65 | 491 | 329 | 689 | 0.76 |
| **Jun-21** | 53 | 307 | 116 | 505 | 0.14 | 0.48 | 315 | 108 | 555 | 0.49 | 364 | 125 | 641 | 0.56 |
| **Jul-21** | 77 | 446 | 261 | 684 | 0.11 | 0.69 | 456 | 254 | 703 | 0.71 | 527 | 295 | 809 | 0.82 |
| **Aug-21** | 462 | 2,636 | 1,381 | 4,246 | 0.05 | 4.1 | 3,076 | 1,539 | 4,976 | 4.78 | 3,583 | 1,793 | 5,797 | 5.56 |
| **Sep-21** | 18 | 103 | 46 | 172 | 0.24 | 0.16 | 105 | 52 | 175 | 0.16 | 122 | 61 | 204 | 0.19 |
| **Oct-21** | 34 | 196 | 92 | 323 | 0.17 | 0.3 | 211 | 85 | 353 | 0.33 | 245 | 99 | 411 | 0.38 |
| **Mar-22** | 2 | 11 | 2 | 32 | 0.71 | 0.02 | 12 | 2 | 36 | 0.02 | 14 | 2 | 42 | 0.02 |
| **Apr-22** | 140 | 794 | 431 | 1,259 | 0.08 | 1.23 | 821 | 441 | 1,286 | 1.28 | 957 | 514 | 1,498 | 1.49 |
| **May-22** | 157 | 898 | 555 | 1,230 | 0.08 | 1.4 | 907 | 576 | 1,222 | 1.41 | 1,057 | 671 | 1,424 | 1.64 |

| Survey | Raw count | Total unapportioned | | | | | Total apportioned | | | | Total apportioned and bias-corrected | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Abundance | LCL | UCL | Precision (CV) | Density ($km^2$) | Abundance | LCL | UCL | Density ($km^2$) | Abundance | LCL | UCL | Density ($km^2$) |
| **Jun-22** | 15 | 86 | 29 | 160 | 0.26 | 0.13 | 87 | 30 | 179 | 0.13 | 100 | 35 | 205 | 0.15 |
| **Jul-22** | 27 | 155 | 81 | 242 | 0.19 | 0.24 | 158 | 77 | 250 | 0.24 | 183 | 89 | 288 | 0.28 |
| **Aug-22** | 95 | 543 | 332 | 784 | 0.10 | 0.84 | 560 | 336 | 786 | 0.87 | 652 | 392 | 916 | 1.01 |
| **Sep-22** | **342** | **1,974** | **1,281** | **2,782** | **0.05** | **3.07** | **2,084** | **1,266** | **2,990** | **3.24** | **2,426** | **1,475** | **3,477** | **3.77** |
| **Jan-23** | 3 | 17 | 3 | 52 | 0.58 | 0.03 | 17 | 3 | 53 | 0.03 | 20 | 4 | 62 | 0.03 |
| **Feb-23** | 7 | 40 | 11 | 69 | 0.38 | 0.06 | 40 | 11 | 70 | 0.06 | 47 | 13 | 81 | 0.07 |
| **Mar-23** | 11 | 64 | 23 | 110 | 0.30 | 0.10 | 65 | 17 | 112 | 0.10 | 75 | 20 | 131 | 0.12 |
| **Apr-23** | 8 | 45 | 11 | 79 | 0.35 | 0.07 | 46 | 17 | 81 | 0.07 | 53 | 20 | 94 | 0.08 |
| **c) Survey Area** | | | | | | | | | | | | | | |
| **May-21** | 102 | 596 | 392 | 818 | 0.10 | 0.67 | 599 | 393 | 850 | 0.68 | 698 | 457 | 990 | 0.79 |
| **Jun-21** | 84 | 494 | 271 | 735 | 0.11 | 0.56 | 506 | 261 | 782 | 0.57 | 585 | 303 | 905 | 0.66 |
| **Jul-21** | 107 | 646 | 423 | 906 | 0.10 | 0.73 | 658 | 418 | 946 | 0.74 | 763 | 487 | 1,092 | 0.86 |
| **Aug-21** | **562** | **3,260** | **1,949** | **4,891** | **0.04** | **3.69** | **4,123** | **2,188** | **6,363** | **4.66** | **4,803** | **2,548** | **7,413** | **5.43** |
| **Sep-21** | 25 | 146 | 94 | 205 | 0.20 | 0.17 | 148 | 95 | 214 | 0.17 | 172 | 110 | 250 | 0.19 |
| **Oct-21** | 39 | 228 | 100 | 375 | 0.16 | 0.26 | 240 | 103 | 393 | 0.27 | 280 | 120 | 458 | 0.32 |
| **Mar-22** | 2 | 11 | 2 | 32 | 0.71 | 0.01 | 11 | 2 | 34 | 0.01 | 13 | 2 | 40 | 0.02 |
| **Apr-22** | 194 | 1,119 | 646 | 1,661 | 0.07 | 1.27 | 1,165 | 689 | 1,702 | 1.32 | 1,358 | 803 | 1,982 | 1.54 |
| **May-22** | 204 | 1,184 | 708 | 1,707 | 0.07 | 1.34 | 1,195 | 666 | 1,684 | 1.35 | 1,392 | 776 | 1,962 | 1.57 |
| **Jun-22** | 25 | 145 | 58 | 237 | 0.20 | 0.16 | 146 | 59 | 250 | 0.16 | 169 | 69 | 288 | 0.19 |
| **Jul-22** | 38 | 222 | 140 | 321 | 0.16 | 0.25 | 223 | 142 | 330 | 0.25 | 259 | 165 | 382 | 0.29 |
| **Aug-22** | 137 | 787 | 460 | 1,201 | 0.09 | 0.89 | 805 | 458 | 1,226 | 0.91 | 938 | 534 | 1,428 | 1.06 |
| **Sep-22** | **495** | **2,888** | **1,727** | **4,277** | **0.04** | **3.27** | **3,001** | **1,745** | **4,345** | **3.39** | **3,492** | **2,032** | **5,051** | **3.95** |
| **Oct-22** | 4 | 24 | 6 | 41 | 0.50 | 0.03 | 25 | 6 | 42 | 0.03 | 29 | 7 | 49 | 0.03 |
| **Jan-23** | 5 | 29 | 5 | 71 | 0.45 | 0.03 | 29 | 5 | 77 | 0.03 | 34 | 6 | 90 | 0.04 |
| **Feb-23** | 7 | 41 | 12 | 69 | 0.38 | 0.05 | 41 | 12 | 76 | 0.05 | 48 | 14 | 89 | 0.05 |
| **Mar-23** | 14 | 82 | 29 | 141 | 0.27 | 0.09 | 83 | 35 | 139 | 0.09 | 97 | 41 | 161 | 0.11 |
| **Apr-23** | 10 | 57 | 23 | 98 | 0.32 | 0.06 | 58 | 23 | 100 | 0.07 | 68 | 27 | 117 | 0.08 |

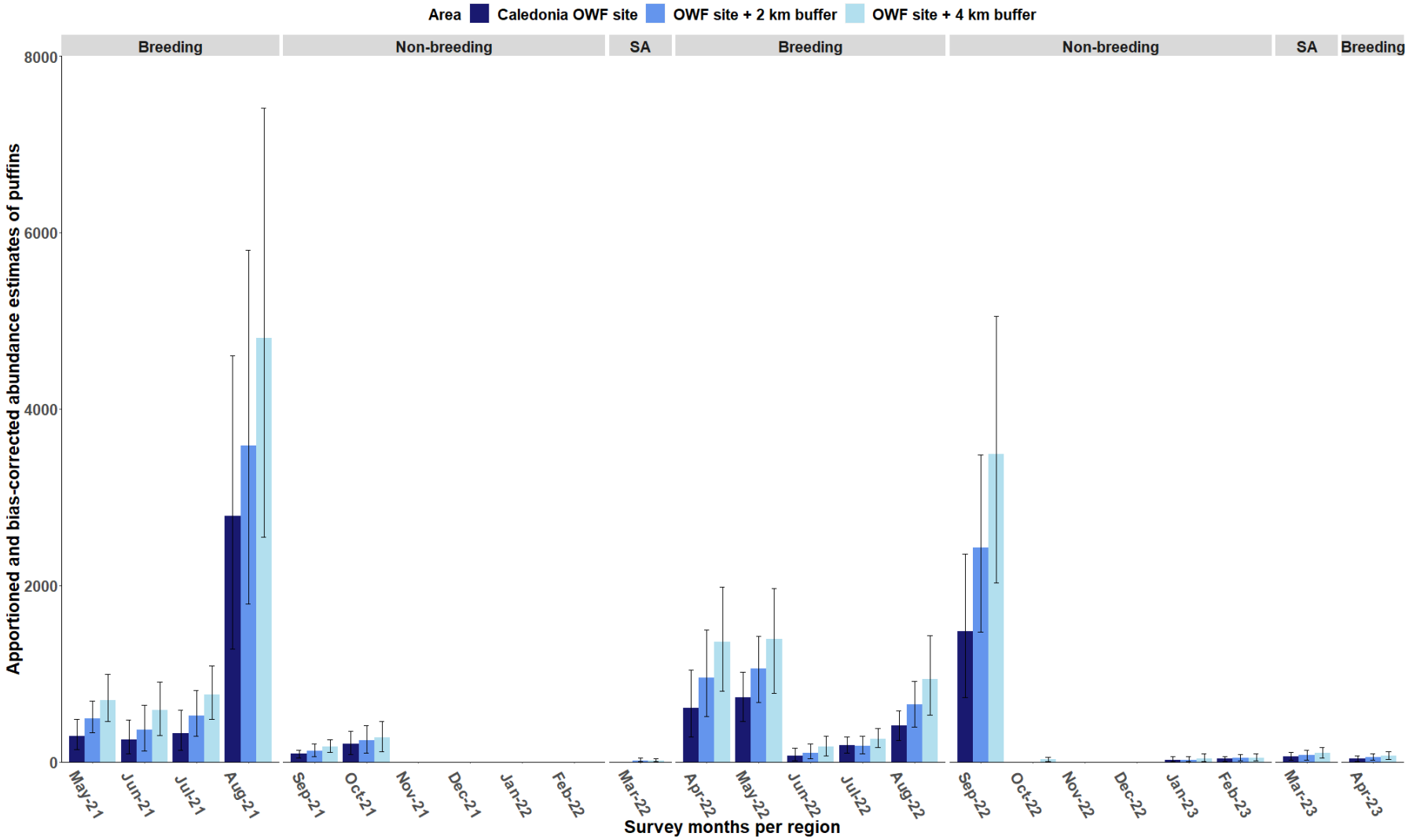



**Figure 29 Bar plot of the monthly apportioned and availability bias-corrected abundances estimates (with 95% confidence intervals) of total puffins recorded in each reporting region of the Survey Area, during the May 2021 to April 2023 survey period. Puffin seasonal periods are also displayed. SA stands for breeding site attendance**

### *Caledonia North*

A total of 1,185 puffins were recorded in Caledonia North Survey Area during both years of baseline surveys (Table 9). Puffins were recorded in every survey except November 2021 to March 2022 and November to December 2022 (Table 9). Puffin were the most abundant during the breeding season (April to mid-August, with birds attending colonies from mid-March onwards). Peak of abundance was recorded in August 2021 (Table 78, Figure 30):

- 195 individuals were recorded in Caledonia North, resulting in an unapportioned mean abundance estimate of 1,130 [463; 1,796], an apportioned mean abundance estimate of 1,156 [467; 1,811] and an apportioned and availability bias-corrected mean abundance estimate of 1,346 [545; 2,109] individuals. These equated to mean density estimates of 5.18 (unapportioned), 5.29 (apportioned) and 6.16 (apportioned and availability bias-corrected) birds/km$^2$.
- 345 individuals were recorded in Caledonia North plus 2 km buffer, resulting in an unapportioned mean abundance estimate of 1,957 [823; 3,211], an apportioned mean abundance estimate of 2,047 [856; 3,383] and an apportioned and availability bias-corrected mean abundance estimate of 2,385 [997; 3,942] individuals. These equated to mean density estimates of 5.21 (unapportioned), 5.45 (apportioned) and 6.35 (apportioned and availability bias-corrected) birds/km$^2$.
- 418 individuals were recorded in Caledonia North Survey Area, resulting in an unapportioned mean abundance estimate of 2,427 [1,115; 3,959], an apportioned mean abundance estimate of 2,532 [1,098; 4,231] and an apportioned and availability bias-corrected mean abundance estimate of 2,950 [1,279; 4,929] individuals. These equated to mean density estimates of 4.36 (unapportioned), 4.54 (apportioned) and 5.29 (apportioned and availability bias-corrected) birds/km$^2$.

During the 2021 breeding season, mean apportioned and availability bias-corrected puffin abundances in Caledonia North Survey Area and reporting regions between May and July were relatively consistent, with the peak occurring in May 2021. In August 2021, a large peak in abundance was observed, which was also the peak breeding season mean apportioned and availability bias-corrected abundance for all reporting regions across the baseline survey period. It is anticipated that rather than a peak of breeding adult birds, the timing of this peak, and the size of the abundances recorded relative to other breeding season surveys, may indicate a post-breeding peak of birds, likely originating from multiple breeding colonies across the wider region. What could be considered to be an equivalent peak occurred in September 2022 (i.e. outside the breeding season). During the 2022 breeding season, abundances were consistent across April and May (and higher than the corresponding abundances recorded in the same months in 2021. In June and July 2022, abundances were considerably lower, with slightly higher mean abundances reported during August 2022. The reason for the different temporal patterns in the 2021 and 2022 breeding seasons is unclear.

Reductions in mean apportioned and availability bias-corrected abundance in the breeding season surveys outside the peak survey month varied from 75% to 99%, with most surveys falling somewhere in the middle of the two extremes of this range. This is indicative of the overall breeding season peak for the baseline survey period being considerably higher than the abundance estimates recorded for all other surveys during this season across both of the breeding seasons within the survey period. This is perhaps related to the presence of a post-breeding season peak in August 2021 (i.e. inside the breeding season).

During the non-breeding season (September to mid-March), puffins were only recorded in September to October 2021, September 2022 and January to March 2023, with a peak recorded in September 2022 (Table 77, Figure 29):

- 107 individuals were recorded in Caledonia North, resulting in an unapportioned mean abundance estimate of 614 [321; 930], an apportioned mean abundance estimate of 644 [327; 978] and an apportioned and availability bias-corrected mean abundance estimate of 750 [381; 1,139] individuals. These equated to mean density estimates of 2.81 (unapportioned), 2.95 (apportioned) and 3.43 (apportioned and availability bias-corrected) birds/km$^2$.
- 193 individuals were recorded in Caledonia North plus 2 km buffer, resulting in an unapportioned mean abundance estimate of 1,121 [691; 1,475], an apportioned mean abundance estimate of 1,178 [769; 1,620] and an apportioned and availability bias-corrected mean abundance estimate of 1,372 [896; 1,887] individuals. These equated to mean density estimates of 2.99 (unapportioned), 3.14 (apportioned) and 3.65 (apportioned and availability bias-corrected) birds/km$^2$.
- 302 individuals were recorded in Caledonia North Survey Area, resulting in an unapportioned mean abundance estimate of 1,759 [920; 2,673], an apportioned mean abundance estimate of 1,829 [978; 2,913] and an apportioned and availability bias-corrected mean abundance estimate of 2,128 [1,139; 3,385] individuals. These equated to mean density estimates of 3.16 (unapportioned), 3.28 (apportioned) and 3.82 (apportioned and availability bias-corrected) birds/km$^2$.

During the two non-breeding seasons covered by the baseline surveys, peak mean apportioned and availability bias-corrected abundances of puffin within Caledonia North Survey Area and reporting regions occurred in September 2022. The timing of this peak is indicative of a post-breeding season aggregation of birds (likely consisting of birds from multiple breeding colonies across the region). A peak abundance estimate in August 2021 (i.e. within the breeding season) is also considered likely to be a post-breeding aggregation of birds, which arguably could be considered a non-breeding count, despite the earlier timing in 2021. The September 2022 mean apportioned and availability bias-corrected abundances were considerably larger than in any other survey during the non-breeding season for this species within Caledonia North Survey Area and reporting regions. Puffin were absent from the surveys carried out between November 2021 and March 2022, and either absent or recorded in very low numbers between October 2022 to April 2023. Reductions in mean apportioned and availability bias-corrected abundance relative to the peak were between 91% to 99%, reflecting the fact that the September 2022 peak was very large relative to the other mean apportioned and availability bias-corrected abundances recorded for puffin during the non-breeding season.

During the breeding site attendance period (March), puffins were recorded absent in March 2022 and in low numbers in March 2023, which is when the peak was recorded (Table 77, Figure 29):

- Six individuals were recorded in Caledonia North, resulting in an unapportioned mean abundance estimate of 35 [6; 70], an apportioned mean abundance estimate of 36 [6; 80] and an apportioned and availability bias-corrected mean abundance estimate of 42 [7; 93] individuals. These equated to mean density estimates of 0.16 (unapportioned), 0.16 (apportioned) and 0.19 (apportioned and availability bias-corrected) birds/km$^2$.
- Seven individuals were recorded in Caledonia North plus 2 km buffer, resulting in an unapportioned mean abundance estimate of 41 [7; 87], an apportioned mean abundance estimate of 42 [7; 90] and an apportioned and availability bias-corrected mean abundance estimate of 49 [8; 105] individuals. These equated to mean density estimates of 0.11 (unapportioned), 0.11 (apportioned) and 0.153 (apportioned and availability bias-corrected) birds/km$^2$.

- Eight individuals were recorded in Caledonia North Survey Area, resulting in an unapportioned mean abundance estimate of 47 [12; 94], an apportioned mean abundance estimate of 48 [12; 103] and an apportioned and availability bias-corrected mean abundance estimate of 56 [14; 120] individuals. These equated to mean density estimates of 0.08 (unapportioned), 0.09 (apportioned) and 0.10 (apportioned and availability bias-corrected) birds/km$^2$.

Measures of precisions were variable for puffin across the survey period (Table 78). During three of 16 surveys in which the species was recorded within Caledonia North, CV values were ≤ 0.16, indicating higher levels of precision (Table 78). The three surveys were within the breeding season, which meant that three of 10 breeding season surveys had a CV value of ≤ 0.16 (Table 78). Higher levels of precision coincided with higher numbers of puffins being recorded (Table 78). Outside the breeding season, when lower numbers of puffins were recorded, CV values were typically calculated to be between 0.2 to 0.6, indicating lower levels of precision (Table 78). For Caledonia North plus buffer regions, CV values were generally lower than the corresponding CV values for Caledonia North, indicating higher precision within these reporting regions (Table 78).

**Table 78** **Raw counts, unapportioned, apportioned, and apportioned and availability bias-corrected abundance and density estimates (birds per km$^2$) of puffins in Caledonia North, Caledonia North plus 2 km buffer and Caledonia North Survey Area during the May 2021 to April 2023 survey period. Colour gradients follow the ascending order of puffin raw counts per season, with light yellow to orange (peak number) for the breeding season months (April to mid-August) and light blue to royal blue (peak number) for the wintering months (September to mid-March). No colours were attributed to the breeding site attendance period (March)**

| Survey | Raw count | Total unapportioned | | | | | Total apportioned | | | | Total apportioned and bias-corrected | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Abundance | LCL | UCL | Precision (CV) | Density (km$^2$) | Abundance | LCL | UCL | Density (km$^2$) | Abundance | LCL | UCL | Density (km$^2$) |
| **a) Caledonia North** | | | | | | | | | | | | | | |
| **May-21** | 24 | 140 | 29 | 280 | 0.20 | 0.64 | 141 | 35 | 284 | 0.65 | 165 | 41 | 330 | 0.75 |
| **Jun-21** | 7 | 41 | 7 | 89 | 0.38 | 0.19 | 42 | 7 | 104 | 0.19 | 47 | 8 | 118 | 0.22 |
| **Jul-21** | 12 | 71 | 24 | 142 | 0.29 | 0.33 | 73 | 15 | 155 | 0.34 | 83 | 17 | 173 | 0.38 |
| **Aug-21** | 195 | 1,130 | 463 | 1,796 | 0.07 | 5.18 | 1,156 | 467 | 1,811 | 5.29 | 1,346 | 545 | 2,109 | 6.16 |
| **Sep-21** | 5 | 29 | 6 | 52 | 0.45 | 0.13 | 30 | 12 | 54 | 0.14 | 34 | 14 | 63 | 0.16 |
| **Oct-21** | 9 | 53 | 12 | 99 | 0.33 | 0.24 | 60 | 13 | 117 | 0.28 | 70 | 15 | 137 | 0.32 |
| **Apr-22** | 49 | 281 | 98 | 517 | 0.14 | 1.29 | 289 | 93 | 544 | 1.32 | 336 | 109 | 634 | 1.54 |
| **May-22** | 44 | 255 | 122 | 389 | 0.15 | 1.17 | 258 | 129 | 389 | 1.18 | 301 | 150 | 453 | 1.38 |
| **Jun-22** | 4 | 23 | 6 | 34 | 0.50 | 0.11 | 23 | 7 | 51 | 0.11 | 26 | 8 | 57 | 0.12 |
| **Jul-22** | 10 | 59 | 12 | 123 | 0.32 | 0.27 | 60 | 12 | 120 | 0.27 | 70 | 14 | 140 | 0.32 |
| **Aug-22** | 10 | 58 | 17 | 104 | 0.32 | 0.27 | 61 | 17 | 111 | 0.28 | 71 | 20 | 129 | 0.32 |
| **Sep-22** | 107 | 614 | 321 | 930 | 0.10 | 2.81 | 644 | 327 | 978 | 2.95 | 750 | 381 | 1,139 | 3.43 |
| **Jan-23** | 3 | 17 | 3 | 52 | 0.58 | 0.08 | 18 | 3 | 54 | 0.08 | 20 | 4 | 63 | 0.09 |
| **Feb-23** | 3 | 17 | 3 | 40 | 0.58 | 0.08 | 18 | 3 | 43 | 0.08 | 21 | 4 | 50 | 0.09 |
| **Mar-23** | 6 | 35 | 6 | 70 | 0.41 | 0.16 | 36 | 6 | 80 | 0.16 | 42 | 7 | 93 | 0.19 |
| **Apr-23** | 1 | 6 | 1 | 17 | 1.00 | 0.03 | 6 | 1 | 17 | 0.03 | 7 | 1 | 20 | 0.03 |
| **b) Caledonia North plus 2 km buffer** | | | | | | | | | | | | | | |
| **May-21** | 41 | 235 | 97 | 400 | 0.16 | 0.63 | 237 | 92 | 387 | 0.63 | 276 | 107 | 450 | 0.73 |
| **Jun-21** | 20 | 116 | 20 | 255 | 0.22 | 0.31 | 117 | 24 | 258 | 0.31 | 135 | 28 | 298 | 0.36 |
| **Jul-21** | 27 | 156 | 52 | 271 | 0.19 | 0.42 | 160 | 44 | 287 | 0.43 | 183 | 50 | 327 | 0.49 |
| **Aug-21** | 345 | 1,957 | 823 | 3,211 | 0.05 | 5.21 | 2,047 | 856 | 3,383 | 5.45 | 2,385 | 997 | 3,942 | 6.35 |
| **Sep-21** | 7 | 40 | 7 | 85 | 0.38 | 0.11 | 42 | 11 | 91 | 0.11 | 49 | 13 | 107 | 0.13 |
| **Oct-21** | 13 | 74 | 13 | 154 | 0.28 | 0.20 | 91 | 16 | 183 | 0.24 | 105 | 18 | 213 | 0.28 |
| **Apr-22** | 77 | 433 | 174 | 747 | 0.11 | 1.15 | 451 | 157 | 790 | 1.20 | 526 | 183 | 920 | 1.4 |
| **May-22** | 80 | 456 | 279 | 666 | 0.11 | 1.22 | 461 | 269 | 658 | 1.23 | 537 | 314 | 767 | 1.43 |
| **Jun-22** | 5 | 29 | 12 | 46 | 0.45 | 0.08 | 29 | 7 | 58 | 0.08 | 33 | 8 | 65 | 0.09 |

| Survey | Raw count | Total unapportioned | | | | | Total apportioned | | | | Total apportioned and bias-corrected | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Abundance | LCL | UCL | Precision (CV) | Density ($km^2$) | Abundance | LCL | UCL | Density ($km^2$) | Abundance | LCL | UCL | Density ($km^2$) |
| **Jul-22** | 10 | 57 | 11 | 120 | 0.32 | 0.15 | 58 | 11 | 123 | 0.15 | 68 | 13 | 144 | 0.18 |
| **Aug-22** | 22 | 126 | 69 | 200 | 0.21 | 0.34 | 130 | 70 | 205 | 0.35 | 151 | 81 | 239 | 0.4 |
| **Sep-22** | **193** | **1,121** | **691** | **1,475** | **0.07** | **2.99** | **1,178** | **769** | **1,620** | **3.14** | **1,372** | **896** | **1,887** | **3.65** |
| **Jan-23** | 3 | 18 | 3 | 53 | 0.58 | 0.05 | 18 | 3 | 55 | 0.05 | 21 | 4 | 64 | 0.06 |
| **Feb-23** | 4 | 23 | 4 | 46 | 0.50 | 0.06 | 23 | 6 | 48 | 0.06 | 27 | 7 | 56 | 0.07 |
| **Mar-23** | 7 | 41 | 7 | 87 | 0.38 | 0.11 | 42 | 7 | 90 | 0.11 | 49 | 8 | 105 | 0.13 |
| **Apr-23** | 2 | 11 | 2 | 29 | 0.71 | 0.03 | 12 | 2 | 27 | 0.03 | 14 | 2 | 31 | 0.04 |
| **c) Caledonia North Survey Area** | | | | | | | | | | | | | | |
| **May-21** | 59 | 345 | 205 | 503 | 0.13 | 0.62 | 348 | 193 | 528 | 0.62 | 405 | 225 | 615 | 0.73 |
| **Jun-21** | 38 | 225 | 95 | 384 | 0.16 | 0.40 | 227 | 84 | 420 | 0.41 | 263 | 98 | 486 | 0.47 |
| **Jul-21** | 46 | 279 | 121 | 466 | 0.15 | 0.50 | 285 | 120 | 508 | 0.51 | 329 | 139 | 585 | 0.59 |
| **Aug-21** | **418** | **2,427** | **1,115** | **3,959** | **0.05** | **4.36** | **2,532** | **1,098** | **4,231** | **4.54** | **2,950** | **1,279** | **4,929** | **5.29** |
| **Sep-21** | 14 | 82 | 35 | 134 | 0.27 | 0.15 | 86 | 36 | 137 | 0.15 | 100 | 42 | 159 | 0.18 |
| **Oct-21** | 16 | 94 | 18 | 187 | 0.25 | 0.17 | 107 | 20 | 205 | 0.19 | 124 | 23 | 239 | 0.22 |
| **Apr-22** | 104 | 599 | 282 | 967 | 0.10 | 1.08 | 623 | 287 | 1,022 | 1.12 | 726 | 335 | 1,190 | 1.3 |
| **May-22** | 105 | 611 | 378 | 831 | 0.10 | 1.10 | 616 | 386 | 853 | 1.11 | 718 | 449 | 993 | 1.29 |
| **Jun-22** | 11 | 64 | 17 | 121 | 0.30 | 0.11 | 64 | 13 | 134 | 0.12 | 74 | 15 | 153 | 0.13 |
| **Jul-22** | 18 | 105 | 53 | 164 | 0.24 | 0.19 | 106 | 47 | 172 | 0.19 | 124 | 55 | 201 | 0.22 |
| **Aug-22** | 29 | 166 | 80 | 269 | 0.19 | 0.30 | 170 | 75 | 281 | 0.30 | 198 | 87 | 327 | 0.36 |
| **Sep-22** | **302** | **1,759** | **920** | **2,673** | **0.06** | **3.16** | **1,829** | **978** | **2,913** | **3.28** | **2,128** | **1,139** | **3,385** | **3.82** |
| **Oct-22** | 4 | 23 | 6 | 41 | 0.50 | 0.04 | 27 | 7 | 49 | 0.05 | 31 | 8 | 58 | 0.06 |
| **Jan-23** | 5 | 29 | 5 | 71 | 0.45 | 0.05 | 29 | 5 | 73 | 0.05 | 34 | 6 | 85 | 0.06 |
| **Feb-23** | 4 | 23 | 4 | 52 | 0.50 | 0.04 | 23 | 4 | 47 | 0.04 | 27 | 5 | 55 | 0.05 |
| **Mar-23** | 8 | 47 | 12 | 94 | 0.35 | 0.08 | 48 | 12 | 103 | 0.09 | 56 | 14 | 120 | 0.1 |
| **Apr-23** | 4 | 23 | 4 | 52 | 0.50 | 0.04 | 25 | 4 | 57 | 0.04 | 29 | 5 | 67 | 0.05 |

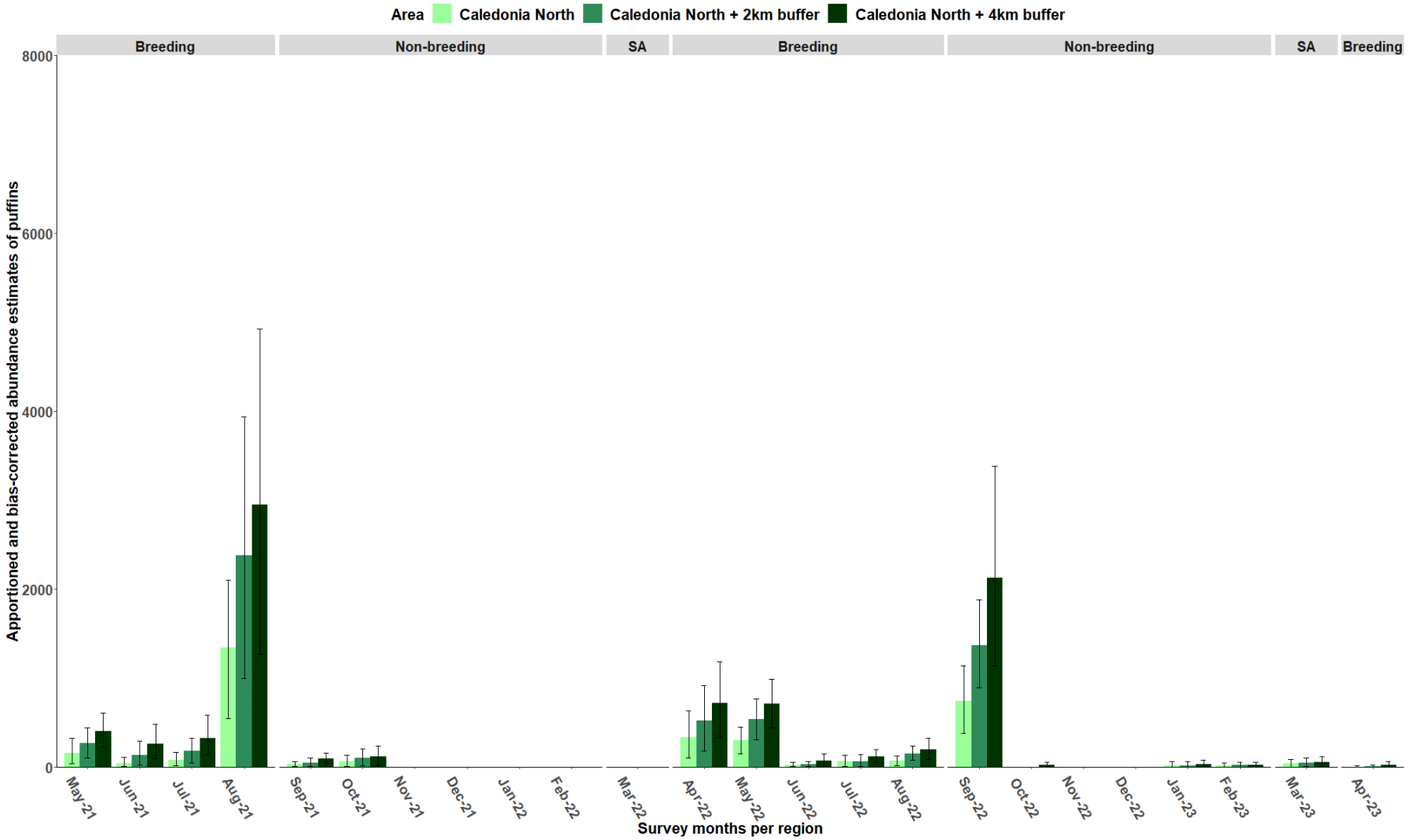



**Figure 30 Bar plot of the monthly apportioned and availability bias-corrected abundance estimates (with 95% confidence intervals) of total puffins recorded in each reporting region of Caledonia North Survey Area, during the May 2021 to April 2023 survey period. Puffin seasonal periods are also displayed. SA stands for breeding site attendance**

### *Caledonia South*

A total of 1,329 puffins were recorded in Caledonia South Survey Area during both years of baseline surveys (Table 10). Puffins were recorded in every survey except November 2021 to February 2022 and November 2022 to January 2023 (Table 10). During the breeding season (April to mid-August, with birds attending colonies from mid-March onwards). Puffin were the most abundant during the breeding season (April to August), with a peak in August 2021 (Table 79, Figure 31):

- 175 individuals were recorded in Caledonia South, resulting in an unapportioned mean abundance estimate of 1,010 [433; 1,605], an apportioned mean abundance estimate of 1,223 [494; 2,139] and an apportioned and availability bias-corrected mean abundance estimate of 1,424 [576; 2,491] individuals. These equated to mean density estimates of 4.80 (unapportioned), 5.81 (apportioned) and 6.77 (apportioned and availability bias-corrected) birds/km$^2$.
- 246 individuals were recorded in Caledonia South plus 2 km buffer, resulting in an unapportioned mean abundance estimate of 1,410 [803; 2,190], an apportioned mean abundance estimate of 1,796 [1,217; 2,935] and an apportioned and availability bias-corrected mean abundance estimate of 2,093 [1,418; 3,420] individuals. These equated to mean density estimates of 3.92 (unapportioned), 4.99 (apportioned) and 5.82 (apportioned and availability bias-corrected) birds/km$^2$.
- 309 individuals were recorded in Caledonia South Survey Area, resulting in an unapportioned mean abundance estimate of 1,777 [1,162; 2,537], an apportioned mean abundance estimate of 2,559 [1,441; 3,960] and an apportioned and availability bias-corrected mean abundance estimate of 2,981 [1,678; 4,614] individuals. These equated to mean density estimates of 3.33 (unapportioned), 4.79 (apportioned) and 5.59 (apportioned and availability bias-corrected) birds/km$^2$.

During the 2021 breeding season, mean apportioned and availability bias-corrected puffin abundances within Caledonia South Survey Area and reporting regions between May and July were very consistent. In August 2021, a large peak in abundance was observed, which was also the peak breeding season mean apportioned and availability bias-corrected abundance for all reporting regions across the baseline survey period. It is anticipated that rather than a peak of breeding adult birds, the timing of this peak, and the size of the abundances recorded relative to other breeding season surveys, may indicate a post-breeding peak of birds, likely originating from multiple breeding colonies across the wider region. What could be considered to be an equivalent peak occurred in September 2022 (i.e. outside the breeding season). During the 2022 breeding season, abundances were consistent across April and May (and higher than the corresponding abundances recorded in the same months in 2021. In June and July 2022, abundances were considerably lower, with higher mean abundances comparable to April and May 2022 reported during August 2022. The reason for the different temporal patterns in the 2021 and 2022 breeding seasons is unclear.

Reductions in mean apportioned and availability bias-corrected abundance in the breeding season surveys outside the peak survey month varied from 66% to 99%, with most surveys falling somewhere in the middle of the two extremes of this range. This is indicative of the overall breeding season peak for the baseline survey period being considerably higher than the abundance estimates recorded for all other surveys during this season across both of the breeding seasons within the survey period. This is perhaps related to the presence of a post-breeding season peak in August 2021 (i.e. inside the breeding season).

During the non-breeding season (September to mid-March), puffins were only recorded present in September to October 2021, September 2022 and January to March 2023, with a peak in September 2022 (Table 79, Figure 31):

- 106 individuals were recorded in Caledonia South, resulting in an unapportioned mean abundance estimate of 618 [326; 985], an apportioned mean abundance estimate of 628 [336; 1,015] and an apportioned and availability bias-corrected mean abundance estimate of 730 [391; 1,177] individuals. These equated to mean density estimates of 2.94 (unapportioned), 2.99 (apportioned) and 3.47 (apportioned and availability bias-corrected) birds/km$^2$.
- 193 individuals were recorded in Caledonia South plus 2 km buffer, resulting in an unapportioned mean abundance estimate of 1,102 [777; 1,468], an apportioned mean abundance estimate of 1,372 [838; 1,591] and an apportioned and availability bias-corrected mean abundance estimate of 1,358 [976; 1,848] individuals. These equated to mean density estimates of 3.07 (unapportioned), 3.24 (apportioned) and 3.77 (apportioned and availability bias-corrected) birds/km$^2$.
- 283 individuals were recorded in Caledonia South Survey Area, resulting in an unapportioned mean abundance estimate of 1,651 [1,190; 2,101], an apportioned mean abundance estimate of 1,717 [1,216; 2,295] and an apportioned and availability bias-corrected mean abundance estimate of 1,996 [1,416; 2,662] individuals. These equated to mean density estimates of 3.1 (unapportioned), 3.22 (apportioned) and 3.74 (apportioned and availability bias-corrected) birds/km$^2$.

During the two non-breeding seasons covered by the baseline surveys, peak mean apportioned and availability bias-corrected abundances of puffin within Caledonia South Survey Area and reporting regions occurred in September 2022. The timing of this peak is indicative of a post-breeding season aggregation of birds (likely consisting of birds from multiple breeding colonies across the region). A peak abundance estimate in August 2021 (i.e. within the breeding season) is also considered likely to be a post-breeding aggregation of birds, which arguably could be considered a non-breeding count, despite the earlier timing in 2021. The September 2022 mean apportioned and availability bias-corrected abundances were considerably larger than in any other survey during the non-breeding season for this species, and puffin were absent from the surveys carried out between November 2021 and February 2022, and either absent or recorded in very low numbers between October 2022 to April 2023. Reductions in mean apportioned and availability bias-corrected abundance relative to the peak were between 81% to >99.5%, reflecting the fact that the September 2022 peak was very large relative to the other peak mean apportioned and availability bias-corrected abundances recorded for puffin during the non-breeding season.

During the breeding site attendance period (March), puffins were recorded in low numbers, with peak numbers in March 2023 (Table 79, Figure 31):

- Three individuals were recorded in Caledonia South, resulting in an unapportioned mean abundance estimate of 17 [6; 35], an apportioned mean abundance estimate of 17 [3; 35] and an apportioned and availability bias-corrected mean abundance estimate of 20 [3; 41] individuals. These equated to mean density estimates of 0.08 (unapportioned), 0.08 (apportioned) and 0.09 (apportioned and availability bias-corrected) birds/km$^2$.
- Five individuals were recorded in Caledonia South plus 2 km buffer, resulting in an unapportioned and apportioned mean abundance estimate of 29 [5; 58-64], and an apportioned and availability bias-corrected mean abundance estimate of 34 [6; 75] individuals. These equated to mean density estimates of 0.08 (unapportioned and apportioned) and 0.09 (apportioned and availability bias-corrected) birds/km$^2$.
- Nine individuals were recorded in Caledonia South Survey Area, resulting in an unapportioned mean abundance estimate of 52 [23; 87], an apportioned mean abundance estimate of 53 [23; 89], and an apportioned and availability bias-corrected mean abundance estimate of 61

[27; 103] individuals. These equated to mean density estimates of 0.10 (unapportioned), 0.1 (apportioned) and 0.11 (apportioned and availability bias-corrected) birds/km$^2$.

Measures of precisions were variable for puffin across the survey period (Table 79). During four of 15 surveys in which the species was recorded within Caledonia South, CV values were ≤ 0.16, indicating higher levels of precision (Table 79). The four surveys were within the breeding season, which meant that four of 10 breeding season surveys had a CV value of ≤ 0.16 (Table 79). Higher levels of precision coincided with higher numbers of puffins being recorded (Table 79). Outside the breeding season, when lower numbers of puffins were recorded, CV values were typically calculated to be between 0.2 to 0.7, indicating lower levels of precision (Table 79). For Caledonia South plus buffer regions, CV values were generally lower than the corresponding CV values for Caledonia South, indicating higher precision within these reporting regions (Table 79).

**Table 79** **Raw counts, unapportioned, apportioned, and apportioned and availability bias-corrected abundance and density estimates (birds per km$^2$) of puffins in Caledonia South, Caledonia South plus 2 km buffer and Caledonia South Survey Area during the May 2021 to April 2023 survey period. Colour gradients follow the ascending order of puffin raw counts per season, with light yellow to orange (peak number) for the breeding season months (April to mid-August) and light blue to royal blue (peak number) for the wintering months (September to mid-March). No colours were attributed to the breeding site attendance period (March)**

| Survey | Raw count | Total unapportioned | | | | | Total apportioned | | | | Total apportioned and bias-corrected | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Abundance | LCL | UCL | Precision (CV) | Density (km$^2$) | Abundance | LCL | UCL | Density (km$^2$) | Abundance | LCL | UCL | Density (km$^2$) |
| **a) Caledonia South** | | | | | | | | | | | | | | |
| **May-21** | 19 | 111 | 70 | 151 | 0.23 | 0.53 | 111 | 64 | 152 | 0.53 | 130 | 75 | 177 | 0.62 |
| **Jun-21** | 31 | 180 | 76 | 320 | 0.18 | 0.86 | 182 | 70 | 320 | 0.87 | 212 | 82 | 373 | 1.01 |
| **Jul-21** | 34 | 199 | 70 | 352 | 0.17 | 0.95 | 202 | 59 | 356 | 0.96 | 235 | 69 | 415 | 1.12 |
| **Aug-21** | 175 | 1,010 | 433 | 1,605 | 0.08 | 4.80 | 1,223 | 494 | 2,139 | 5.81 | 1,424 | 576 | 2,491 | 6.77 |
| **Sep-21** | 8 | 46 | 23 | 81 | 0.35 | 0.22 | 47 | 23 | 77 | 0.22 | 54 | 27 | 89 | 0.26 |
| **Oct-21** | 19 | 111 | 53 | 182 | 0.23 | 0.53 | 120 | 42 | 203 | 0.57 | 140 | 49 | 236 | 0.66 |
| **Apr-22** | 39 | 225 | 86 | 380 | 0.16 | 1.07 | 233 | 87 | 390 | 1.11 | 271 | 102 | 454 | 1.29 |
| **May-22** | 63 | 364 | 219 | 502 | 0.13 | 1.73 | 368 | 215 | 509 | 1.75 | 428 | 250 | 594 | 2.04 |
| **Jun-22** | 6 | 35 | 6 | 93 | 0.41 | 0.17 | 35 | 6 | 94 | 0.17 | 41 | 7 | 109 | 0.19 |
| **Jul-22** | 17 | 99 | 52 | 152 | 0.24 | 0.47 | 100 | 48 | 159 | 0.48 | 116 | 56 | 182 | 0.55 |
| **Aug-22** | 49 | 282 | 161 | 408 | 0.14 | 1.34 | 290 | 152 | 437 | 1.38 | 338 | 177 | 509 | 1.61 |
| **Sep-22** | 106 | 618 | 326 | 985 | 0.10 | 2.94 | 628 | 336 | 1,015 | 2.99 | 730 | 391 | 1,177 | 3.47 |
| **Feb-23** | 2 | 11 | 2 | 29 | 0.71 | 0.05 | 11 | 2 | 23 | 0.05 | 13 | 2 | 27 | 0.06 |
| **Mar-23** | 3 | 17 | 6 | 35 | 0.58 | 0.08 | 17 | 3 | 35 | 0.08 | 20 | 3 | 41 | 0.09 |
| **Apr-23** | 4 | 23 | 6 | 46 | 0.50 | 0.11 | 23 | 6 | 46 | 0.11 | 27 | 7 | 54 | 0.13 |
| **b) Caledonia South plus 2 km buffer** | | | | | | | | | | | | | | |
| **May-21** | 45 | 260 | 173 | 376 | 0.15 | 0.72 | 261 | 169 | 374 | 0.73 | 304 | 197 | 435 | 0.85 |
| **Jun-21** | 48 | 278 | 110 | 470 | 0.14 | 0.77 | 286 | 115 | 506 | 0.80 | 331 | 134 | 584 | 0.92 |
| **Jul-21** | 61 | 355 | 169 | 570 | 0.13 | 0.99 | 363 | 178 | 599 | 1.01 | 421 | 207 | 694 | 1.17 |
| **Aug-21** | 246 | 1,410 | 803 | 2,190 | 0.06 | 3.92 | 1,796 | 1,217 | 2,935 | 4.99 | 2,093 | 1,418 | 3,420 | 5.82 |
| **Sep-21** | 13 | 75 | 35 | 127 | 0.28 | 0.21 | 76 | 36 | 122 | 0.21 | 88 | 41 | 142 | 0.24 |
| **Oct-21** | 25 | 145 | 64 | 226 | 0.20 | 0.40 | 154 | 79 | 252 | 0.43 | 179 | 92 | 293 | 0.5 |
| **Mar-22** | 2 | 11 | 2 | 32 | 0.71 | 0.03 | 12 | 3 | 36 | 0.03 | 14 | 3 | 42 | 0.04 |
| **Apr-22** | 73 | 417 | 200 | 669 | 0.12 | 1.16 | 431 | 191 | 699 | 1.20 | 502 | 222 | 814 | 1.4 |
| **May-22** | 94 | 539 | 321 | 774 | 0.10 | 1.50 | 544 | 303 | 772 | 1.51 | 634 | 353 | 900 | 1.76 |
| **Jun-22** | 12 | 68 | 23 | 131 | 0.29 | 0.19 | 68 | 17 | 132 | 0.19 | 80 | 20 | 154 | 0.22 |

| Survey | Raw count | Total unapportioned | | | | | Total apportioned | | | | Total apportioned and bias-corrected | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Abundance | LCL | UCL | Precision (CV) | Density ($km^2$) | Abundance | LCL | UCL | Density ($km^2$) | Abundance | LCL | UCL | Density ($km^2$) |
| **Jul-22** | 19 | 110 | 52 | 174 | 0.23 | 0.31 | 111 | 54 | 181 | 0.31 | 128 | 63 | 208 | 0.36 |
| **Aug-22** | 85 | 486 | 280 | 726 | 0.11 | 1.35 | 499 | 287 | 744 | 1.39 | 581 | 334 | 866 | 1.62 |
| **Sep-22** | 193 | 1,102 | 777 | 1,468 | 0.07 | 3.07 | 1,167 | 838 | 1,591 | 3.24 | 1,358 | 976 | 1,848 | 3.77 |
| **Feb-23** | 4 | 23 | 6 | 46 | 0.50 | 0.06 | 23 | 4 | 51 | 0.06 | 27 | 5 | 59 | 0.07 |
| **Mar-23** | 5 | 29 | 5 | 58 | 0.45 | 0.08 | 29 | 5 | 64 | 0.08 | 34 | 6 | 75 | 0.09 |
| **Apr-23** | 6 | 34 | 6 | 67 | 0.41 | 0.09 | 34 | 6 | 63 | 0.10 | 40 | 7 | 73 | 0.11 |
| **c) Caledonia South Survey Area** | | | | | | | | | | | | | | |
| **May-21** | 61 | 354 | 215 | 534 | 0.13 | 0.66 | 356 | 209 | 539 | 0.67 | 414 | 244 | 628 | 0.78 |
| **Jun-21** | 76 | 442 | 232 | 680 | 0.11 | 0.83 | 452 | 217 | 739 | 0.85 | 522 | 251 | 854 | 0.98 |
| **Jul-21** | 88 | 528 | 348 | 745 | 0.11 | 0.99 | 538 | 358 | 771 | 1.01 | 626 | 417 | 895 | 1.17 |
| **Aug-21** | 309 | 1,777 | 1,162 | 2,537 | 0.06 | 3.33 | 2,559 | 1,441 | 3,960 | 4.79 | 2,981 | 1,678 | 4,614 | 5.59 |
| **Sep-21** | 21 | 122 | 64 | 186 | 0.22 | 0.23 | 123 | 70 | 188 | 0.23 | 143 | 82 | 219 | 0.27 |
| **Oct-21** | 31 | 180 | 81 | 290 | 0.18 | 0.34 | 188 | 83 | 314 | 0.35 | 219 | 97 | 366 | 0.41 |
| **Mar-22** | 2 | 11 | 2 | 32 | 0.71 | 0.02 | 11 | 2 | 34 | 0.02 | 13 | 2 | 40 | 0.02 |
| **Apr-22** | 116 | 665 | 344 | 1,032 | 0.09 | 1.25 | 691 | 343 | 1,104 | 1.29 | 805 | 400 | 1,286 | 1.51 |
| **May-22** | 149 | 856 | 517 | 1,190 | 0.08 | 1.60 | 862 | 514 | 1,225 | 1.62 | 1,004 | 599 | 1,427 | 1.88 |
| **Jun-22** | 18 | 104 | 41 | 180 | 0.24 | 0.19 | 105 | 41 | 187 | 0.20 | 122 | 48 | 218 | 0.23 |
| **Jul-22** | 29 | 168 | 104 | 237 | 0.19 | 0.31 | 169 | 106 | 238 | 0.32 | 196 | 123 | 275 | 0.37 |
| **Aug-22** | 126 | 722 | 390 | 1,135 | 0.09 | 1.35 | 736 | 388 | 1,132 | 1.38 | 857 | 452 | 1,319 | 1.61 |
| **Sep-22** | 283 | 1,651 | 1,190 | 2,101 | 0.06 | 3.10 | 1,717 | 1,216 | 2,295 | 3.22 | 1,996 | 1,416 | 2,662 | 3.74 |
| **Oct-22** | 1 | 6 | 1 | 18 | 1.00 | 0.01 | 6 | 1 | 19 | 0.01 | 7 | 1 | 22 | 0.01 |
| **Feb-23** | 4 | 23 | 4 | 46 | 0.50 | 0.04 | 23 | 4 | 52 | 0.04 | 27 | 5 | 61 | 0.05 |
| **Mar-23** | 9 | 52 | 23 | 87 | 0.33 | 0.10 | 53 | 23 | 89 | 0.10 | 61 | 27 | 103 | 0.11 |
| **Apr-23** | 6 | 34 | 6 | 63 | 0.41 | 0.06 | 34 | 6 | 70 | 0.06 | 40 | 7 | 82 | 0.08 |

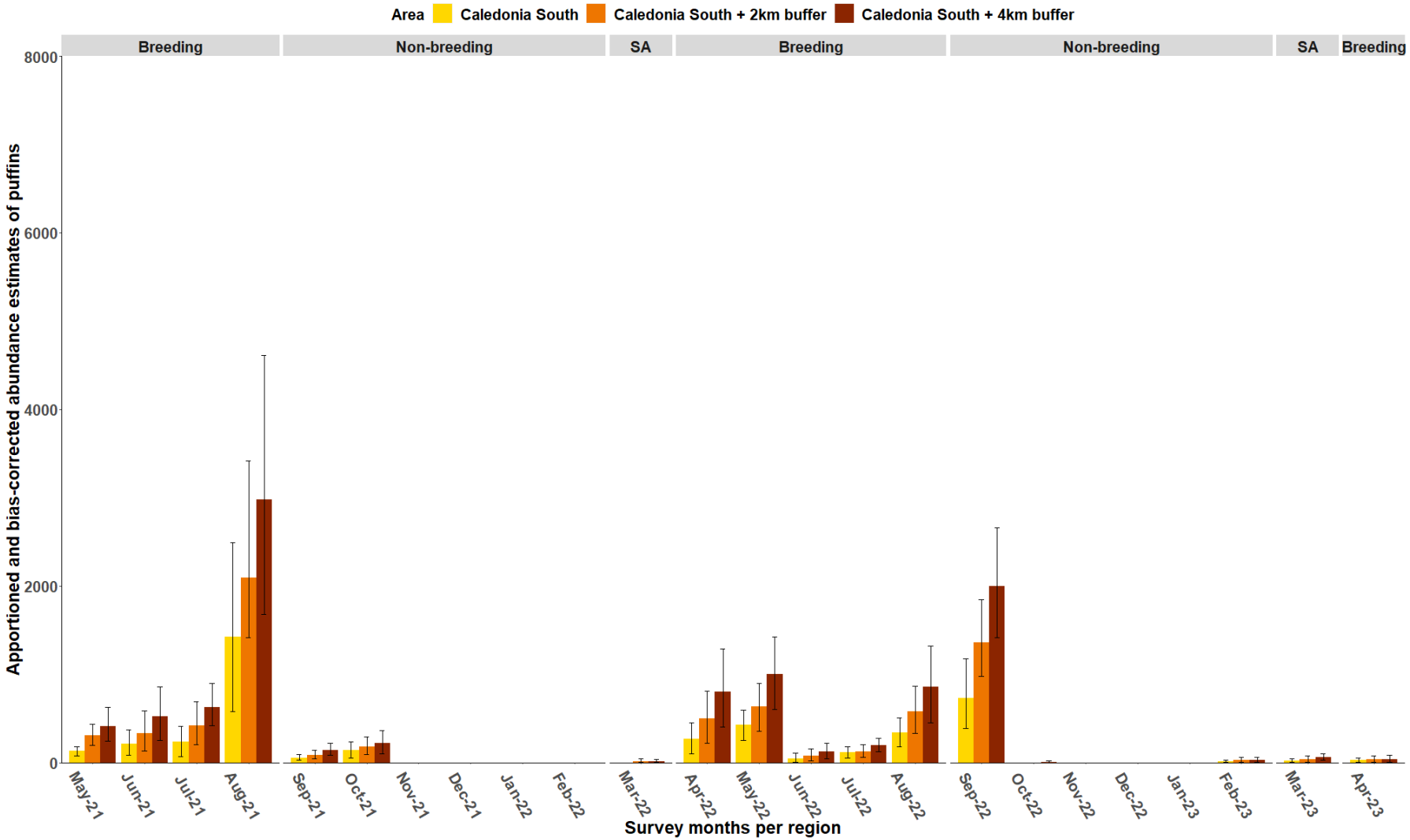



**Figure 31 Bar plot of the monthly apportioned and availability bias-corrected abundance estimates (with 95% confidence intervals) of total puffins recorded in each reporting region of Caledonia South Survey Area, during the May 2021 to April 2023 survey period. Puffin seasonal periods are also displayed. SA stands for breeding site attendance.**

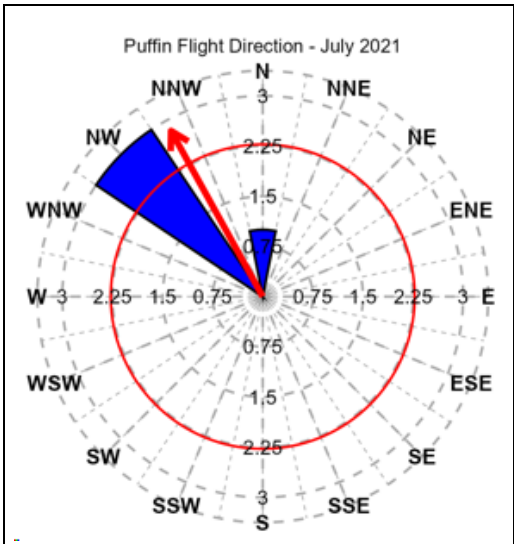
### *ii. Distribution and behaviour*

Maps of distribution are shown in Appendix 4: Figures A4.177-194. While puffins were mostly loosely distributed across the Survey Area, higher numbers of records were made in Caledonia South and its Buffer Zone in June, July, September, and October 2021 and in August 2022 (Figures A4.178-179, 181-182, 188). In August 2021, October 2022 and January 2023, the opposite pattern was observed with individuals largely recorded in the north of the Survey Area (Figure A4.180, 190-191). The two individuals recorded in March 2022 were both located in the southwest of Caledonia South Buffer Zone (Figure A4.183).

Significant predominant direction of flight was recorded in:

- **July**
  - 2021 north-northwest (Figure 32a)
- **September**
  - 2022 west (Figure 32b)

As very few birds were recorded in flight in other surveys, they were too infrequent to determine any preference in flight direction (Appendix 5, Figure A5.20).




| | | | |
|---|---|---|---|
| Number of Observations | 4 | Number of Observations | 5 |
| Mean Vector (μ) | 331.121 | Mean Vector (μ) | 279.888 |
| Length of Mean Vector (r) | 0.943 | Length of Mean Vector (r) | 0.907 |
| Rayleigh Test (Z) | 3.558 | Rayleigh Test (Z) | 4.112 |
| Rayleigh Test (p) | 0.016 | Rayleigh Test (p) | 0.008 |
| **a July 2021** | | **b September 2022** | |

**Figure 32 Summary of flight direction of puffins within surveys where a significant flight direction was recorded during the May 2021 to April 2023 survey period**

## 4.23 Unidentified auk species

### *i. Abundance and density estimates*

A total of 432 unidentified auks were recorded in the Survey Area during both years of baseline surveys (Table 8). Auk species were recorded in every survey except November and December 2021 (Table 8). Peak numbers were recorded in August 2021, when 190 unidentified auks were recorded in the Survey Area (Table 80). This resulted in an unapportioned mean abundance estimate of 1,102 [354; 1,903] individuals and a mean density estimate of 1.25 birds/km$^2$ (Table 80). Auk species have been used for apportioning to species level where possible.

**Table 80 Raw counts, unapportioned abundance and density estimates (birds per km$^2$) of auk species in Caledonia OWF, Caledonia OWF plus 2 km buffer and the Survey Area during the May 2021 to April 2023 survey period**

| Survey | Raw count | Total unapportioned | | | | |
|---|---|---|---|---|---|---|
| | | Abundance | LCL | UCL | Precision (CV) | Density (km$^2$) |
| **a) Caledonia OWF** | | | | | | |
| **May-21** | 3 | 17 | 3 | 41 | 0.58 | 0.04 |
| **Jun-21** | 4 | 23 | 6 | 47 | 0.50 | 0.05 |
| **Jul-21** | 19 | 112 | 59 | 165 | 0.23 | 0.26 |
| **Aug-21** | 51 | 295 | 98 | 596 | 0.14 | 0.69 |
| **Sep-21** | 3 | 17 | 3 | 46 | 0.58 | 0.04 |
| **Oct-21** | 11 | 64 | 23 | 117 | 0.30 | 0.15 |
| **Jan-22** | 1 | 6 | 1 | 17 | 1.00 | 0.01 |
| **Feb-22** | 1 | 5 | 1 | 16 | 1.00 | 0.01 |
| **Mar-22** | 3 | 16 | 3 | 43 | 0.58 | 0.04 |
| **Apr-22** | 6 | 35 | 12 | 63 | 0.41 | 0.08 |
| **May-22** | 15 | 87 | 35 | 156 | 0.26 | 0.2 |
| **Jun-22** | 3 | 17 | 3 | 40 | 0.58 | 0.04 |
| **Jul-22** | 10 | 58 | 23 | 94 | 0.32 | 0.14 |
| **Aug-22** | 4 | 23 | 6 | 52 | 0.50 | 0.05 |
| **Sep-22** | 24 | 139 | 29 | 295 | 0.20 | 0.33 |
| **Oct-22** | 2 | 12 | 2 | 35 | 0.71 | 0.03 |
| **Nov-22** | 1 | 6 | 1 | 18 | 1.00 | 0.01 |
| **Dec-22** | 1 | 6 | 1 | 18 | 1.00 | 0.01 |
| **Jan-23** | 1 | 6 | 1 | 17 | 1.00 | 0.01 |
| **Feb-23** | 1 | 6 | 1 | 17 | 1.00 | 0.01 |
| **Mar-23** | 2 | 12 | 2 | 29 | 0.71 | 0.03 |
| **Apr-23** | 1 | 6 | 1 | 17 | 1.00 | 0.01 |
| **b) Caledonia plus 2 km buffer** | | | | | | |
| **May-21** | 5 | 29 | 5 | 57 | 0.45 | 0.05 |
| **Jun-21** | 7 | 41 | 7 | 87 | 0.38 | 0.06 |
| **Jul-21** | 37 | 214 | 116 | 330 | 0.16 | 0.33 |
| **Aug-21** | 94 | 536 | 194 | 964 | 0.10 | 0.83 |
| **Sep-21** | 9 | 52 | 9 | 98 | 0.33 | 0.08 |
| **Oct-21** | 14 | 81 | 29 | 144 | 0.27 | 0.13 |
| **Jan-22** | 1 | 6 | 1 | 17 | 1.00 | 0.01 |
| **Feb-22** | 3 | 16 | 3 | 38 | 0.58 | 0.02 |
| **Mar-22** | 3 | 16 | 3 | 42 | 0.58 | 0.02 |
| **Apr-22** | 11 | 62 | 23 | 108 | 0.30 | 0.1 |
| **May-22** | 20 | 114 | 57 | 183 | 0.22 | 0.18 |
| **Jun-22** | 7 | 40 | 7 | 80 | 0.38 | 0.06 |
| **Jul-22** | 15 | 86 | 35 | 150 | 0.26 | 0.13 |
| **Aug-22** | 8 | 46 | 17 | 74 | 0.35 | 0.07 |

| Survey | Raw count | Total unapportioned | | | | |
|---|---|---|---|---|---|---|
| | | Abundance | LCL | UCL | Precision (CV) | Density (km²) |
| **Sep-22** | 40 | 231 | 110 | 375 | 0.16 | 0.36 |
| **Oct-22** | 2 | 12 | 2 | 35 | 0.71 | 0.02 |
| **Nov-22** | 1 | 6 | 1 | 17 | 1.00 | 0.01 |
| **Dec-22** | 3 | 18 | 3 | 35 | 0.58 | 0.03 |
| **Jan-23** | 1 | 6 | 1 | 17 | 1.00 | 0.01 |
| **Feb-23** | 1 | 6 | 1 | 17 | 1.00 | 0.01 |
| **Mar-23** | 2 | 12 | 2 | 29 | 0.71 | 0.02 |
| **Apr-23** | 7 | 40 | 7 | 85 | 0.38 | 0.06 |
| **c) Survey Area** | | | | | | |
| **May-21** | 6 | 35 | 6 | 76 | 0.41 | 0.04 |
| **Jun-21** | 10 | 59 | 18 | 106 | 0.32 | 0.07 |
| **Jul-21** | 44 | 266 | 163 | 398 | 0.15 | 0.3 |
| **Aug-21** | 190 | 1,102 | 354 | 1,903 | 0.07 | 1.25 |
| **Sep-21** | 12 | 70 | 23 | 129 | 0.29 | 0.08 |
| **Oct-21** | 16 | 94 | 35 | 158 | 0.25 | 0.11 |
| **Jan-22** | 1 | 6 | 1 | 17 | 1.00 | 0.01 |
| **Feb-22** | 3 | 16 | 3 | 44 | 0.58 | 0.02 |
| **Mar-22** | 3 | 16 | 3 | 38 | 0.58 | 0.02 |
| **Apr-22** | 19 | 110 | 52 | 167 | 0.23 | 0.12 |
| **May-22** | 24 | 139 | 58 | 226 | 0.20 | 0.16 |
| **Jun-22** | 8 | 46 | 8 | 98 | 0.35 | 0.05 |
| **Jul-22** | 16 | 94 | 41 | 158 | 0.25 | 0.11 |
| **Aug-22** | 8 | 46 | 17 | 80 | 0.35 | 0.05 |
| **Sep-22** | 46 | 268 | 123 | 420 | 0.15 | 0.3 |
| **Oct-22** | 3 | 18 | 3 | 47 | 0.58 | 0.02 |
| **Nov-22** | 2 | 12 | 2 | 29 | 0.71 | 0.01 |
| **Dec-22** | 3 | 18 | 3 | 35 | 0.58 | 0.02 |
| **Jan-23** | 1 | 6 | 1 | 18 | 1.00 | 0.01 |
| **Feb-23** | 2 | 12 | 2 | 35 | 0.71 | 0.01 |
| **Mar-23** | 5 | 29 | 6 | 59 | 0.45 | 0.03 |
| **Apr-23** | 10 | 57 | 23 | 98 | 0.32 | 0.06 |

In Caledonia North Survey Area, peak numbers were recorded in September 2022, with 30 individuals recorded (Table 81). This resulted in an unapportioned mean abundance estimate of 175 [64; 297] individuals, which equated to a mean density estimate of 0.31 birds/km² (Table 81).

**Table 81 Raw counts, unapportioned abundance and density estimates (birds per km²) of auk species in Caledonia North, Caledonia North plus 2 km buffer and Caledonia North Survey Area during the May 2021 to April 2023 survey period**

| Survey | Raw count | Total unapportioned | | | | |
|---|---|---|---|---|---|---|
| | | Abundance | LCL | UCL | Precision (CV) | Density (km²) |
| **a) Caledonia North** | | | | | | |
| **May-21** | 3 | 17 | 3 | 47 | 0.58 | 0.08 |
| **Jun-21** | 2 | 12 | 2 | 35 | 0.71 | 0.05 |
| **Jul-21** | 8 | 47 | 8 | 101 | 0.35 | 0.22 |
| **Aug-21** | 5 | 29 | 5 | 64 | 0.45 | 0.13 |
| **Sep-21** | 1 | 6 | 1 | 17 | 1.00 | 0.03 |
| **Oct-21** | 3 | 18 | 3 | 41 | 0.58 | 0.08 |
| **Jan-22** | 1 | 6 | 1 | 17 | 1.00 | 0.03 |
| **Feb-22** | 1 | 5 | 1 | 16 | 1.00 | 0.02 |
| **Mar-22** | 1 | 5 | 1 | 16 | 1.00 | 0.02 |
| **Apr-22** | 2 | 11 | 2 | 29 | 0.71 | 0.05 |

| Survey | Raw count | Total unapportioned | | | | |
|---|---|---|---|---|---|---|
| | | Abundance | LCL | UCL | Precision (CV) | Density (km²) |
| **May-22** | 9 | 52 | 12 | 110 | 0.33 | 0.24 |
| **Jul-22** | 3 | 18 | 6 | 35 | 0.58 | 0.08 |
| **Aug-22** | 1 | 6 | 1 | 17 | 1.00 | 0.03 |
| **Sep-22** | 15 | 86 | 15 | 184 | 0.26 | 0.39 |
| **Oct-22** | 2 | 12 | 2 | 35 | 0.71 | 0.05 |
| **Jan-23** | 1 | 6 | 1 | 17 | 1.00 | 0.03 |
| **Feb-23** | 1 | 6 | 1 | 17 | 1.00 | 0.03 |
| **Mar-23** | 2 | 12 | 2 | 29 | 0.71 | 0.05 |
| **b) Caledonia North plus 2 km buffer** | | | | | | |
| **May-21** | 3 | 17 | 3 | 40 | 0.58 | 0.05 |
| **Jun-21** | 2 | 12 | 2 | 35 | 0.71 | 0.03 |
| **Jul-21** | 14 | 81 | 29 | 144 | 0.27 | 0.22 |
| **Aug-21** | 18 | 102 | 18 | 272 | 0.24 | 0.27 |
| **Sep-21** | 5 | 28 | 5 | 57 | 0.45 | 0.07 |
| **Oct-21** | 8 | 46 | 17 | 80 | 0.35 | 0.12 |
| **Jan-22** | 1 | 6 | 1 | 17 | 1.00 | 0.02 |
| **Feb-22** | 3 | 16 | 3 | 43 | 0.58 | 0.04 |
| **Mar-22** | 1 | 5 | 1 | 16 | 1.00 | 0.01 |
| **Apr-22** | 6 | 34 | 6 | 62 | 0.41 | 0.09 |
| **May-22** | 13 | 74 | 28 | 131 | 0.28 | 0.20 |
| **Jun-22** | 2 | 12 | 2 | 29 | 0.71 | 0.03 |
| **Jul-22** | 6 | 34 | 6 | 69 | 0.41 | 0.09 |
| **Aug-22** | 1 | 6 | 1 | 17 | 1.00 | 0.02 |
| **Sep-22** | 26 | 151 | 64 | 256 | 0.20 | 0.40 |
| **Oct-22** | 2 | 12 | 2 | 35 | 0.71 | 0.03 |
| **Dec-22** | 2 | 12 | 2 | 29 | 0.71 | 0.03 |
| **Jan-23** | 1 | 6 | 1 | 18 | 1.00 | 0.02 |
| **Feb-23** | 1 | 6 | 1 | 17 | 1.00 | 0.02 |
| **Mar-23** | 2 | 12 | 2 | 29 | 0.71 | 0.03 |
| **Apr-23** | 6 | 34 | 6 | 69 | 0.41 | 0.09 |
| **c) Caledonia North Survey Area** | | | | | | |
| **May-21** | 3 | 18 | 3 | 47 | 0.58 | 0.03 |
| **Jun-21** | 3 | 18 | 3 | 41 | 0.58 | 0.03 |
| **Jul-21** | 18 | 109 | 48 | 176 | 0.24 | 0.20 |
| **Aug-21** | 21 | 122 | 21 | 331 | 0.22 | 0.22 |
| **Sep-21** | 7 | 41 | 12 | 76 | 0.38 | 0.07 |
| **Oct-21** | 10 | 58 | 23 | 99 | 0.32 | 0.10 |
| **Jan-22** | 1 | 6 | 1 | 17 | 1.00 | 0.01 |
| **Feb-22** | 3 | 17 | 3 | 44 | 0.58 | 0.03 |
| **Mar-22** | 1 | 5 | 1 | 16 | 1.00 | 0.01 |
| **Apr-22** | 9 | 52 | 17 | 92 | 0.33 | 0.09 |
| **May-22** | 16 | 93 | 35 | 163 | 0.25 | 0.17 |
| **Jun-22** | 2 | 12 | 2 | 29 | 0.71 | 0.02 |
| **Jul-22** | 6 | 35 | 6 | 76 | 0.41 | 0.06 |
| **Aug-22** | 1 | 6 | 1 | 17 | 1.00 | 0.01 |
| **Sep-22** | 30 | 175 | 64 | 297 | 0.18 | 0.31 |
| **Oct-22** | 3 | 18 | 3 | 41 | 0.58 | 0.03 |
| **Dec-22** | 3 | 18 | 3 | 35 | 0.58 | 0.03 |
| **Jan-23** | 1 | 6 | 1 | 18 | 1.00 | 0.01 |
| **Feb-23** | 1 | 6 | 1 | 17 | 1.00 | 0.01 |
| **Mar-23** | 4 | 23 | 6 | 53 | 0.50 | 0.04 |

| Survey | Raw count | Total unapportioned | | | | |
|---|---|---|---|---|---|---|
| | | Abundance | LCL | UCL | Precision (CV) | Density (km²) |
| **Apr-23** | 8 | 46 | 17 | 80 | 0.35 | 0.08 |

In Caledonia South Survey Area, peak numbers were recorded in August 2021, with 183 individuals recorded (Table 82). This resulted in an unapportioned mean abundance estimate of 1,053 [299; 1,869] individuals, which equated to a mean density estimate of 1.97 birds/km² (Table 82).

**Table 82 Raw counts, unapportioned abundance and density estimates (birds per km²) of auk species in Caledonia South, Caledonia South plus 2 km buffer and Caledonia South Survey Area during the May 2021 to April 2023 survey period**

| Survey | Raw count | Total unapportioned | | | | |
|---|---|---|---|---|---|---|
| | | Abundance | LCL | UCL | Precision (CV) | Density (km²) |
| **a) Caledonia South** | | | | | | |
| **Jun-21** | 2 | 12 | 2 | 29 | 0.71 | 0.06 |
| **Jul-21** | 11 | 65 | 23 | 111 | 0.30 | 0.31 |
| **Aug-21** | 46 | 266 | 58 | 577 | 0.15 | 1.26 |
| **Sep-21** | 2 | 12 | 2 | 29 | 0.71 | 0.06 |
| **Oct-21** | 8 | 47 | 12 | 100 | 0.35 | 0.22 |
| **Mar-22** | 2 | 11 | 2 | 32 | 0.71 | 0.05 |
| **Apr-22** | 4 | 23 | 4 | 46 | 0.50 | 0.11 |
| **May-22** | 6 | 35 | 12 | 69 | 0.41 | 0.17 |
| **Jun-22** | 3 | 17 | 3 | 41 | 0.58 | 0.08 |
| **Jul-22** | 7 | 41 | 12 | 76 | 0.38 | 0.19 |
| **Aug-22** | 3 | 17 | 3 | 40 | 0.58 | 0.08 |
| **Sep-22** | 9 | 52 | 9 | 111 | 0.33 | 0.25 |
| **Nov-22** | 1 | 6 | 1 | 18 | 1.00 | 0.03 |
| **Dec-22** | 1 | 6 | 1 | 18 | 1.00 | 0.03 |
| **Apr-23** | 1 | 6 | 1 | 17 | 1.00 | 0.03 |
| **b) Caledonia South plus 2 km buffer** | | | | | | |
| **May-21** | 2 | 12 | 2 | 35 | 0.71 | 0.03 |
| **Jun-21** | 5 | 29 | 5 | 70 | 0.45 | 0.08 |
| **Jul-21** | 29 | 169 | 81 | 273 | 0.19 | 0.47 |
| **Aug-21** | 84 | 482 | 161 | 912 | 0.11 | 1.34 |
| **Sep-21** | 4 | 23 | 6 | 40 | 0.50 | 0.06 |
| **Oct-21** | 10 | 58 | 12 | 110 | 0.32 | 0.16 |
| **Mar-22** | 2 | 11 | 2 | 32 | 0.71 | 0.03 |
| **Apr-22** | 7 | 40 | 11 | 86 | 0.38 | 0.11 |
| **May-22** | 8 | 46 | 11 | 86 | 0.35 | 0.13 |
| **Jun-22** | 5 | 28 | 5 | 74 | 0.45 | 0.08 |
| **Jul-22** | 11 | 64 | 29 | 104 | 0.30 | 0.18 |
| **Aug-22** | 7 | 40 | 11 | 69 | 0.38 | 0.11 |
| **Sep-22** | 22 | 126 | 51 | 211 | 0.21 | 0.35 |
| **Nov-22** | 1 | 6 | 1 | 17 | 1.00 | 0.02 |
| **Dec-22** | 1 | 6 | 1 | 17 | 1.00 | 0.02 |
| **Mar-23** | 1 | 6 | 1 | 17 | 1.00 | 0.02 |
| **Apr-23** | 3 | 17 | 3 | 45 | 0.58 | 0.05 |
| **c) Caledonia South Survey Area** | | | | | | |
| **May-21** | 3 | 17 | 3 | 41 | 0.58 | 0.03 |
| **Jun-21** | 8 | 46 | 8 | 99 | 0.35 | 0.09 |
| **Jul-21** | 37 | 222 | 120 | 336 | 0.16 | 0.42 |
| **Aug-21** | 183 | 1,053 | 299 | 1,869 | 0.07 | 1.97 |
| **Sep-21** | 7 | 41 | 7 | 93 | 0.38 | 0.08 |
| **Oct-21** | 12 | 70 | 23 | 122 | 0.29 | 0.13 |

| Survey | Raw count | Total unapportioned | | | | |
|---|---|---|---|---|---|---|
| | | Abundance | LCL | UCL | Precision (CV) | Density (km$^2$) |
| **Mar-22** | 2 | 11 | 2 | 32 | 0.71 | 0.02 |
| **Apr-22** | 13 | 75 | 23 | 138 | 0.28 | 0.14 |
| **May-22** | 10 | 57 | 23 | 98 | 0.32 | 0.11 |
| **Jun-22** | 7 | 41 | 7 | 98 | 0.38 | 0.08 |
| **Jul-22** | 13 | 75 | 35 | 122 | 0.28 | 0.14 |
| **Aug-22** | 7 | 40 | 11 | 75 | 0.38 | 0.07 |
| **Sep-22** | 29 | 169 | 88 | 251 | 0.19 | 0.32 |
| **Oct-22** | 2 | 12 | 2 | 35 | 0.71 | 0.02 |
| **Nov-22** | 2 | 12 | 2 | 29 | 0.71 | 0.02 |
| **Dec-22** | 1 | 6 | 1 | 18 | 1.00 | 0.01 |
| **Feb-23** | 1 | 6 | 1 | 17 | 1.00 | 0.01 |
| **Mar-23** | 3 | 17 | 3 | 35 | 0.58 | 0.03 |
| **Apr-23** | 4 | 23 | 4 | 52 | 0.50 | 0.04 |

#### *ii. Distribution and behaviour*

Maps of distribution of unidentified auks are shown in Appendix 4: Figures A4.195-216. Unidentified auks were recorded in the north and the southeast of the Survey Area in May 2021 (Figure A4.195) and largely in the east to southeast in June 2021 (Figure A4.196). Individuals were loosely distributed throughout the Survey Area in July, September, October 2021 and April, May, and September 2022 (Figure A4.197, 199-200, 204-204, 209). Highest numbers in the south of the Survey Area were recorded in August 2021 (Figure A4.198). In January, February, and October 2022, and in April 2023, unidentified auks were mainly recorded in Caledonia North and its Buffer Zone (Figure A4.201-202, 210, 216). Few records scattered across the Survey Area were made in November 2022 and March 2023 (Figure A4.211-215).

As very few birds were recorded in flight, they were too infrequent to determine any preference in flight direction (Appendix 5, Figure A5.21).

### 4.24 Great northern diver

#### *i. Abundance and density estimates*

Two great northern divers were recorded in the Survey Area during the first year of the baseline surveys, and none were recorded the second year of surveys (Table 8 to Table 10). They were only recorded in Caledonia South (Table 83 to Table 85). A single great northern diver was recorded in each of the June and November 2021 surveys, therefore, abundance and density estimates were very low (Table 83, Table 85).

Measures of precisions were high, which was likely related to the low numbers of individuals recorded in each region (CV > 0.16; Table 83 to Table 85).

**Table 83 Raw counts, unapportioned and apportioned abundance and density estimates (birds per km$^2$) of great northern divers in Caledonia OWF, Caledonia OWF plus 2 km buffer and the Survey Area during the May 2021 to April 2023 survey period**

| Survey | Raw count | Total unapportioned | | | | | Total apportioned | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Abundance | LCL | UCL | Precision (CV) | Density (km$^2$) | Abundance | LCL | UCL | Density (km$^2$) |
| **a) Caledonia OWF** | | | | | | | | | | |
| **Jun-21** | 1 | 6 | 1 | 18 | 1.00 | 0.01 | 6 | 1 | 18 | 0.01 |
| **Nov-21** | 1 | 6 | 1 | 17 | 1.00 | 0.01 | 6 | 1 | 17 | 0.01 |
| **b) Caledonia OWF plus 2 km buffer** | | | | | | | | | | |
| **Jun-21** | 1 | 6 | 1 | 17 | 1.00 | 0.01 | 6 | 1 | 17 | 0.01 |

| Survey | Raw count | Total unapportioned | | | | | Total apportioned | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Abundance | LCL | UCL | Precision (CV) | Density (km²) | Abundance | LCL | UCL | Density (km²) |
| **Nov-21** | 1 | 6 | 1 | 17 | 1.00 | 0.01 | 6 | 1 | 17 | 0.01 |
| **c) Survey Area** | | | | | | | | | | |
| **Jun-21** | 1 | 6 | 1 | 18 | 1.00 | 0.01 | 6 | 1 | 18 | 0.01 |
| **Nov-21** | 1 | 6 | 1 | 17 | 1.00 | 0.01 | 6 | 1 | 17 | 0.01 |

**Table 84 Raw counts, unapportioned and apportioned abundance and density estimates (birds per km²) of red-throated divers in Caledonia North, Caledonia North plus 2 km buffer and Caledonia North Survey Area during the May 2021 to April 2023 survey period**

| Survey | Raw count | Total unapportioned | | | | | Total apportioned | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Abundance | LCL | UCL | Precision (CV) | Density (km²) | Abundance | LCL | UCL | Density (km²) |
| **a) Caledonia North** | | | | | | | | | | |
| None recorded | | | | | | | | | | |
| **b) Caledonia North plus 2 km buffer** | | | | | | | | | | |
| None recorded | | | | | | | | | | |
| **c) Caledonia North Survey Area** | | | | | | | | | | |
| None recorded | | | | | | | | | | |

**Table 85 Raw counts, unapportioned and apportioned abundance and density estimates (birds per km²) of great northern divers in Caledonia South, Caledonia South plus 2 km buffer and Caledonia South Survey Area during the May 2021 to April 2023 survey period**

| Survey | Raw count | Total unapportioned | | | | | Total apportioned | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Abundance | LCL | UCL | Precision (CV) | Density (km²) | Abundance | LCL | UCL | Density (km²) |
| **a) Caledonia South** | | | | | | | | | | |
| **Jun-21** | 1 | 6 | 1 | 17 | 1.00 | 0.03 | 6 | 1 | 17 | 0.03 |
| **Nov-21** | 1 | 6 | 1 | 17 | 1.00 | 0.03 | 6 | 1 | 17 | 0.03 |
| **b) Caledonia South plus 2 km buffer** | | | | | | | | | | |
| **Jun-21** | 1 | 6 | 1 | 17 | 1.00 | 0.02 | 6 | 1 | 17 | 0.02 |
| **Nov-21** | 1 | 6 | 1 | 17 | 1.00 | 0.02 | 6 | 1 | 17 | 0.02 |
| **c) Caledonia South Survey Area** | | | | | | | | | | |
| **Jun-21** | 1 | 6 | 1 | 17 | 1.00 | 0.01 | 6 | 1 | 17 | 0.01 |
| **Nov-21** | 1 | 6 | 1 | 17 | 1.00 | 0.01 | 6 | 1 | 17 | 0.01 |

#### *ii. Distribution and behaviour*

Great northern divers were only recorded within Caledonia South (Appendix 4, Figures A4.217-218). Both great northern divers were recorded along the boundary between Caledonia South and its Buffer Zone, with the single individual recorded in the southwest in June 2021 and in the west in November 2021 (Appendix 4, Figure A4.217-218).

### 4.25 Red-throated diver

#### *i. Abundance and density estimates*

A single red-throated diver was recorded in the Survey Area during the second year of the baseline surveys (Table 8). The individual was recorded in October 2022 in Caledonia South (Table 86 to Table 88). The abundance and density estimates were therefore very low (Table 86 to Table 88).

Measures of precisions were high, which was likely related to the low numbers of individuals recorded in each region (CV > 0.16; Table 86 to Table 88).

**Table 86** **Raw counts, unapportioned and apportioned abundance and density estimates (birds per km$^2$) of red-throated divers in Caledonia OWF, Caledonia OWF plus 2 km buffer and the Survey Area during the May 2021 to April 2023 survey period**

| Survey | Raw count | Total unapportioned | | | | | Total apportioned | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Abundance | LCL | UCL | Precision (CV) | Density (km$^2$) | Abundance | LCL | UCL | Density (km$^2$) |
| **a) Caledonia OWF** | | | | | | | | | | |
| **Oct-22** | 1 | 6 | 1 | 18 | 1.00 | 0.01 | 6 | 1 | 18 | 0.01 |
| **b) Caledonia OWF plus 2 km buffer** | | | | | | | | | | |
| **Oct-22** | 1 | 6 | 1 | 17 | 1.00 | 0.01 | 6 | 1 | 17 | 0.01 |
| **c) Survey Area** | | | | | | | | | | |
| **Oct-22** | 1 | 6 | 1 | 18 | 1.00 | 0.01 | 6 | 1 | 18 | 0.01 |

**Table 87** **Raw counts, unapportioned and apportioned abundance and density estimates (birds per km$^2$) of red-throated divers in Caledonia North, Caledonia North plus 2 km buffer and Caledonia North Survey Area during the May 2021 to April 2023 survey period**

| Survey | Raw count | Total unapportioned | | | | | Total apportioned | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Abundance | LCL | UCL | Precision (CV) | Density (km$^2$) | Abundance | LCL | UCL | Density (km$^2$) |
| **a) Caledonia North** | | | | | | | | | | |
| None recorded | | | | | | | | | | |
| **b) Caledonia North plus 2 km buffer** | | | | | | | | | | |
| None recorded | | | | | | | | | | |
| **c) Caledonia North Survey Area** | | | | | | | | | | |
| **Oct-22** | 1 | 6 | 1 | 18 | 1.00 | 0.01 | 6 | 1 | 18 | 0.01 |

**Table 88** **Raw counts, unapportioned and apportioned abundance and density estimates (birds per km$^2$) of red-throated divers in Caledonia South, Caledonia South plus 2 km buffer and Caledonia South Survey Area during the May 2021 to April 2023 survey period**

| Survey | Raw count | Total unapportioned | | | | | Total apportioned | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Abundance | LCL | UCL | Precision (CV) | Density (km$^2$) | Abundance | LCL | UCL | Density (km$^2$) |
| **a) Caledonia South** | | | | | | | | | | |
| **Oct-22** | 1 | 6 | 1 | 18 | 1.00 | 0.03 | 6 | 1 | 18 | 0.03 |
| **b) Caledonia South plus 2 km buffer** | | | | | | | | | | |
| **Oct-22** | 1 | 6 | 1 | 17 | 1.00 | 0.02 | 6 | 1 | 17 | 0.02 |
| **c) Caledonia South Survey Area** | | | | | | | | | | |
| **Oct-22** | 1 | 6 | 1 | 18 | 1.00 | 0.01 | 6 | 1 | 18 | 0.01 |

### *ii. Distribution and behaviour*

In October 2022, the single red-throated diver was recorded in the north of Caledonia South, near the border with Caledonia North (Appendix 4, Figure A4.219).

As only one bird was recorded in flight, they were too infrequent to determine any preference in flight direction (Appendix 5, Figure A5. 22).

## 4.26 Fulmar

### *i. Abundance and density estimates*

#### *Caledonia OWF*

A total of 4,618 fulmars were recorded in the Survey Area during both years of baseline surveys (Table 8). Fulmars were recorded in every survey (Table 8). Fulmars were the most abundant during the breeding season (April to mid-September). A peak of abundance was recorded in July 2022 (Table 89, Figure 33):

- 705 individuals were recorded in Caledonia OWF, resulting in an unapportioned mean abundance estimate of 4,124 [2,351; 6,147] and an apportioned abundance estimate of 4,123 [1,896; 6,732] individuals. These equated to mean density estimates of 9.65 (unapportioned) and 9.64 (apportioned) birds/km$^2$.
- 1,096 individuals were recorded in Caledonia OWF plus 2 km buffer, resulting in an unapportioned mean abundance estimate of 6,311 [3,783; 9,270] and an apportioned abundance estimate of 6,310 [3,484; 10,358] individuals. These equated to mean density estimates of 9.81 (unapportioned) and 9.80 (apportioned) birds/km$^2$.
- 1,631 individuals were recorded in the Survey Area, resulting in an unapportioned mean abundance estimate of 9,532 [4,342; 15,617] and an apportioned abundance estimate of 9,533 [3,887; 16,136] individuals. These equated to mean density estimates of 10.79 (unapportioned) and 10.78 (apportioned) birds/km$^2$.

During the breeding seasons covered by the baseline surveys, very obvious peaks in fulmar abundance were recorded in July 2021 and 2022, with relatively consistent, and considerably lower numbers, recorded in other breeding season surveys. The peak mean abundance of fulmar within Caledonia OWF and its reporting regions was around 30% to 50% (depending on the reporting region considered) greater than the next highest mean abundance recorded, in July 2021. Mean abundances in the ten other surveys during the breeding seasons covered were 93% to 98% lower than the peak mean abundance. The data indicate that whilst larger numbers of fulmar were present within the Survey Area at a specific time within both breeding seasons covered by the baseline surveys (i.e. July), they were present in much lower numbers during the remainder of the breeding seasons covered by the baseline surveys.

During the non-breeding season (mid-September to March), fulmars were recorded in highest numbers in November, with a peak in November 2022 (Table 89, Figure 33):

- 125 individuals were recorded in Caledonia OWF, resulting in an unapportioned mean abundance estimate of 735 [512; 1,000] and apportioned abundance estimate of 740 [480; 1,044] individuals. These equated to mean density estimates of 1.72 (unapportioned) and 1.73 (apportioned) birds/km$^2$.
- 196 individuals were recorded in Caledonia OWF plus 2 km buffer, resulting in an unapportioned mean unapportioned abundance estimate of 1,136 [840; 1,472] and apportioned abundance estimate of 1,141 [824; 1,510] individuals. Both equated to a mean density estimate of 1.77 birds/km$^2$.
- 252 individuals were recorded in the Survey Area, resulting in a mean unapportioned abundance estimate of 1,486 [1,032; 1,922] and apportioned abundance estimate of 1,497 [998; 1,988] individuals. These equated to mean density estimates of 1.68 (unapportioned) and 1.69 (apportioned) birds/km$^2$.

As with breeding season mean abundances, the data indicates that during a specific period within both non-breeding seasons covered by the surveys (i.e. November, which recorded similar abundances in both survey years), fulmar were present in larger numbers than the rest of the non-breeding season. In the ten other non-breeding season months covered by the baseline surveys, mean abundances in this were 76% to 98% lower, with mean abundances for most surveys being closer to the higher end of these reductions.

Very good measures of precisions were calculated for most survey months (CV ≤ 0.16), with 19 of the 24 baseline surveys for Caledonia OWF reporting CV values of ≤ 0.16 (Table 89). The five exceptions, all occurring during the winter months, coincided with lower numbers of birds being recorded (Table 89).

**Table 89 Raw counts, unapportioned and apportioned abundance and density estimates (birds per km²) of fulmars in Caledonia OWF, Caledonia OWF plus 2 km buffer and the Survey Area during the May 2021 to April 2023 survey period. Colour gradients follow the ascending order of fulmar raw counts per season, with light yellow to orange (peak number) for the breeding season months (April to mid-September) and light blue to royal blue (peak number) for the wintering months (mid-September to March)**

| Survey | Raw count | Total unapportioned | | | | | Total apportioned | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Abundance | LCL | UCL | Precision (CV) | Density (km²) | Abundance | LCL | UCL | Density (km²) |
| a) | Caledonia OWF | | | | | | | | | |
| May-21 | 43 | 251 | 181 | 315 | 0.15 | 0.59 | 251 | 164 | 350 | 0.59 |
| Jun-21 | 40 | 235 | 141 | 346 | 0.16 | 0.55 | 234 | 124 | 358 | 0.55 |
| Jul-21 | 466 | 2,748 | 714 | 6,511 | 0.05 | 6.43 | 2,748 | 683 | 6,517 | 6.43 |
| Aug-21 | 138 | 799 | 602 | 1,030 | 0.09 | 1.87 | 798 | 561 | 1,071 | 1.87 |
| Sep-21 | 50 | 290 | 203 | 383 | 0.14 | 0.68 | 290 | 162 | 435 | 0.68 |
| Oct-21 | 3 | 18 | 3 | 47 | 0.58 | 0.04 | 18 | 3 | 47 | 0.04 |
| Nov-21 | 122 | 709 | 122 | 1,847 | 0.09 | 1.66 | 709 | 150 | 1,830 | 1.66 |
| Dec-21 | 85 | 493 | 296 | 720 | 0.11 | 1.15 | 493 | 290 | 719 | 1.15 |
| Jan-22 | 25 | 145 | 87 | 203 | 0.20 | 0.34 | 145 | 64 | 237 | 0.34 |
| Feb-22 | 36 | 194 | 113 | 297 | 0.17 | 0.45 | 194 | 92 | 297 | 0.45 |
| Mar-22 | 8 | 43 | 16 | 75 | 0.35 | 0.1 | 43 | 13 | 81 | 0.10 |
| Apr-22 | 48 | 276 | 48 | 530 | 0.14 | 0.65 | 277 | 61 | 582 | 0.65 |
| May-22 | 20 | 116 | 75 | 162 | 0.22 | 0.27 | 116 | 58 | 197 | 0.27 |
| Jun-22 | 96 | 552 | 276 | 862 | 0.10 | 1.29 | 551 | 264 | 902 | 1.29 |
| Jul-22 | 705 | 4,124 | 2,351 | 6,147 | 0.04 | 9.65 | 4,123 | 1,896 | 6,732 | 9.64 |
| Aug-22 | 44 | 254 | 150 | 363 | 0.15 | 0.59 | 254 | 131 | 369 | 0.59 |
| Sep-22 | 18 | 104 | 52 | 162 | 0.24 | 0.24 | 104 | 35 | 185 | 0.24 |
| Nov-22 | 125 | 735 | 512 | 1,000 | 0.09 | 1.72 | 740 | 480 | 1,044 | 1.73 |
| Dec-22 | 41 | 240 | 100 | 410 | 0.16 | 0.56 | 240 | 102 | 427 | 0.56 |
| Jan-23 | 14 | 82 | 47 | 134 | 0.27 | 0.19 | 82 | 31 | 157 | 0.19 |
| Feb-23 | 15 | 86 | 52 | 121 | 0.26 | 0.2 | 86 | 41 | 138 | 0.20 |
| Mar-23 | 49 | 286 | 158 | 420 | 0.14 | 0.67 | 292 | 147 | 460 | 0.68 |
| Apr-23 | 13 | 74 | 34 | 119 | 0.28 | 0.17 | 74 | 17 | 147 | 0.17 |
| b) | Caledonia OWF plus 2 km buffer | | | | | | | | | |
| May-21 | 76 | 437 | 345 | 534 | 0.11 | 0.68 | 436 | 293 | 598 | 0.68 |
| Jun-21 | 68 | 394 | 249 | 563 | 0.12 | 0.61 | 395 | 243 | 574 | 0.61 |
| Jul-21 | 629 | 3,644 | 1,170 | 8,058 | 0.04 | 5.66 | 3,643 | 1,066 | 8,266 | 5.66 |
| Aug-21 | 220 | 1,255 | 896 | 1,586 | 0.07 | 1.95 | 1,255 | 873 | 1,626 | 1.95 |
| Sep-21 | 65 | 373 | 270 | 477 | 0.12 | 0.58 | 374 | 224 | 545 | 0.58 |
| Oct-21 | 7 | 40 | 7 | 81 | 0.38 | 0.06 | 41 | 7 | 92 | 0.06 |
| Nov-21 | 155 | 886 | 206 | 1,985 | 0.08 | 1.38 | 886 | 236 | 2,081 | 1.38 |
| Dec-21 | 129 | 739 | 447 | 1,088 | 0.09 | 1.15 | 739 | 441 | 1,134 | 1.15 |

| Survey | Raw count | Total unapportioned | | | | | Total apportioned | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Abundance | LCL | UCL | Precision (CV) | Density (km²) | Abundance | LCL | UCL | Density (km²) |
| Jan-22 | 47 | 269 | 171 | 371 | 0.15 | 0.42 | 269 | 139 | 429 | 0.42 |
| Feb-22 | 56 | 300 | 198 | 407 | 0.13 | 0.47 | 300 | 177 | 439 | 0.47 |
| Mar-22 | 13 | 69 | 32 | 106 | 0.28 | 0.11 | 69 | 29 | 117 | 0.11 |
| Apr-22 | 61 | 346 | 125 | 607 | 0.13 | 0.54 | 346 | 113 | 641 | 0.54 |
| May-22 | 45 | 257 | 149 | 412 | 0.15 | 0.4 | 258 | 115 | 452 | 0.40 |
| Jun-22 | 149 | 854 | 493 | 1,243 | 0.08 | 1.33 | 853 | 429 | 1,318 | 1.32 |
| Jul-22 | 1,096 | 6,311 | 3,783 | 9,270 | 0.03 | 9.81 | 6,310 | 3,484 | 10,358 | 9.80 |
| Aug-22 | 71 | 406 | 275 | 555 | 0.12 | 0.63 | 406 | 189 | 670 | 0.63 |
| Sep-22 | 34 | 196 | 110 | 294 | 0.17 | 0.3 | 196 | 80 | 329 | 0.30 |
| Nov-22 | 196 | 1,136 | 840 | 1,472 | 0.07 | 1.77 | 1,141 | 824 | 1,510 | 1.77 |
| Dec-22 | 63 | 368 | 198 | 607 | 0.13 | 0.57 | 368 | 175 | 618 | 0.57 |
| Jan-23 | 25 | 145 | 93 | 209 | 0.20 | 0.23 | 145 | 79 | 221 | 0.23 |
| Feb-23 | 22 | 126 | 74 | 177 | 0.21 | 0.2 | 126 | 66 | 183 | 0.20 |
| Mar-23 | 67 | 388 | 197 | 591 | 0.12 | 0.6 | 393 | 198 | 638 | 0.61 |
| Apr-23 | 24 | 136 | 51 | 244 | 0.20 | 0.21 | 136 | 34 | 272 | 0.21 |
| c) | Survey Area | | | | | | | | | |
| May-21 | 91 | 532 | 392 | 672 | 0.10 | 0.6 | 531 | 339 | 748 | 0.60 |
| Jun-21 | 105 | 618 | 429 | 818 | 0.10 | 0.7 | 618 | 406 | 847 | 0.70 |
| Jul-21 | 790 | 4,770 | 1,678 | 9,890 | 0.04 | 5.4 | 4,770 | 1,510 | 10,035 | 5.39 |
| Aug-21 | 285 | 1,653 | 1,149 | 2,147 | 0.06 | 1.87 | 1,653 | 1,126 | 2,141 | 1.87 |
| Sep-21 | 113 | 661 | 509 | 837 | 0.09 | 0.75 | 661 | 416 | 942 | 0.75 |
| Oct-21 | 12 | 70 | 12 | 146 | 0.29 | 0.08 | 71 | 12 | 158 | 0.08 |
| Nov-21 | 180 | 1,048 | 297 | 2,235 | 0.07 | 1.19 | 1,048 | 288 | 2,247 | 1.19 |
| Dec-21 | 187 | 1,090 | 740 | 1,509 | 0.07 | 1.23 | 1,090 | 728 | 1,538 | 1.23 |
| Jan-22 | 55 | 319 | 203 | 435 | 0.13 | 0.36 | 319 | 177 | 487 | 0.36 |
| Feb-22 | 80 | 439 | 296 | 604 | 0.11 | 0.5 | 439 | 269 | 615 | 0.50 |
| Mar-22 | 28 | 151 | 86 | 227 | 0.19 | 0.17 | 152 | 75 | 227 | 0.17 |
| Apr-22 | 70 | 404 | 179 | 669 | 0.12 | 0.46 | 404 | 150 | 721 | 0.46 |
| May-22 | 51 | 296 | 157 | 482 | 0.14 | 0.33 | 297 | 127 | 517 | 0.34 |
| Jun-22 | 204 | 1,181 | 677 | 1,765 | 0.07 | 1.34 | 1,180 | 665 | 1,782 | 1.33 |
| Jul-22 | 1,631 | 9,532 | 4,342 | 15,617 | 0.02 | 10.79 | 9,533 | 3,887 | 16,136 | 10.78 |
| Aug-22 | 114 | 655 | 465 | 850 | 0.09 | 0.74 | 655 | 356 | 1,011 | 0.74 |
| Sep-22 | 47 | 274 | 169 | 391 | 0.15 | 0.31 | 274 | 140 | 420 | 0.31 |
| Oct-22 | 4 | 24 | 4 | 59 | 0.50 | 0.03 | 24 | 4 | 70 | 0.03 |
| Nov-22 | 252 | 1,486 | 1,032 | 1,922 | 0.06 | 1.68 | 1,497 | 998 | 1,988 | 1.69 |
| Dec-22 | 87 | 513 | 295 | 761 | 0.11 | 0.58 | 513 | 277 | 802 | 0.58 |
| Jan-23 | 53 | 312 | 194 | 470 | 0.14 | 0.35 | 312 | 164 | 476 | 0.35 |
| Feb-23 | 37 | 214 | 145 | 278 | 0.16 | 0.24 | 215 | 134 | 295 | 0.24 |
| Mar-23 | 96 | 564 | 317 | 834 | 0.10 | 0.64 | 569 | 288 | 877 | 0.64 |
| Apr-23 | 39 | 224 | 121 | 344 | 0.16 | 0.25 | 224 | 97 | 396 | 0.25 |

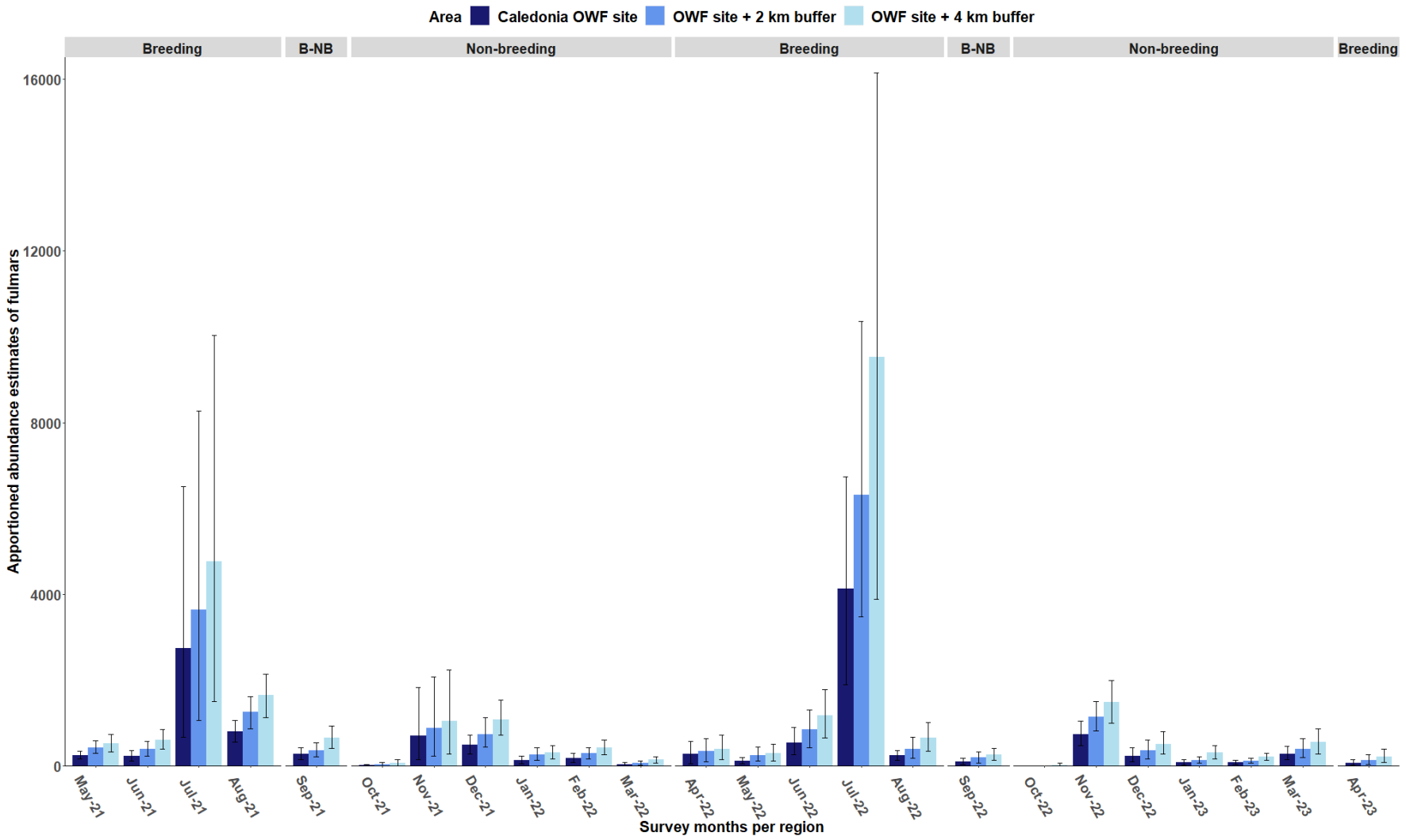



**Figure 33 Bar plot of monthly apportioned abundance estimates (with 95% confidence intervals) of the total fulmars recorded in each reporting region of the Survey Area, during the May 2021 to April 2023 survey period. Fulmar seasonal periods are also displayed. B-NB corresponds to month split between breeding (B) and non-breeding (NB)**

### *Caledonia North*

A total of 1,818 fulmars were recorded in Caledonia North Survey Area during both years of baseline surveys (Table 9). Fulmar were recorded in every survey, except October 2022 (Table 9). Fulmars were the most abundant during the breeding season (April to mid-September). A peak of abundance was recorded in July 2022 (Table 90, Figure 34):

- 179 individuals were recorded in Caledonia North, resulting in an unapportioned mean abundance estimate of 1,048 [427; 1,762] and an apportioned mean abundance estimate of 1,048 [409; 1,815] individuals. Both equated to a mean density estimate of 4.80 birds/km$^2$.
- 287 individuals were recorded in Caledonia North plus 2 km buffer, resulting in an unapportioned mean abundance estimate of 1,643 [876; 2,444] and an apportioned mean abundance estimate of 1,642 [807; 2,513] individuals. These equated to mean density estimates of 4.38 (unapportioned) and 4.37 (apportioned) birds/km$^2$
- 405 individuals were recorded in Caledonia North Survey Area, resulting in an unapportioned mean abundance estimate of 2,370 [1,598; 3,260] and an apportioned mean abundance estimate of 2,370 [1,551; 3,289] individuals. Both equated to mean density estimate of 4.25 birds/km$^2$.

During the breeding seasons in Caledonia North Survey Area covered by the baseline surveys, relatively subtle peaks in fulmar abundance were recorded in July 2021 and 2022 (when the overall baseline survey seasonal peak was observed), with consistently low numbers recorded in most other breeding season surveys. Mean abundances in the other surveys during the breeding seasons covered were 45% to 97% lower than the peak mean abundance, with the average reduction located towards the upper end of the range.

During the non-breeding season (mid-September to March), fulmars were only recorded in higher numbers in November, with a peak in November 2022 (Table 90, Figure 34):

- 70 individuals were recorded in Caledonia North, resulting in an unapportioned mean abundance estimate of 413 [230; 637] and apportioned abundance estimate of 412 [219; 636] individuals. Both equated to a mean density estimate of 1.89 birds/km$^2$.
- 119 individuals were recorded in Caledonia North plus 2 km buffer, resulting in an unapportioned mean abundance estimate of 686 [421; 980] individuals, which equated to a mean density estimate of 1.83 birds/km$^2$.
- 167 individuals were recorded in Caledonia North Survey Area, resulting in an unapportioned mean abundance estimate of 985 [655; 1,333] and apportioned abundance estimate of 990 [621; 1,384] individuals. Both equated to mean density estimates of 1.77 (unapportioned) and 1.78 (apportioned) birds/km$^2$.

The data indicates that during the non-breeding season, fulmar abundance in Caledonia North Survey Area was generally very low, with small peaks recorded In December 2021 and November 2022. In the other non-breeding season months covered by the baseline surveys, mean abundances in this were 45% to 99% lower than the peak mean abundance, with mean abundances for most surveys being closer to the higher end of these reductions.

Good measures of precisions were calculated for some, but not all, survey months (CV ≤ 0.16), with six of the 23 baseline surveys in which fulmar was recorded within Caledonia North reporting CV values of ≤ 0.16 (Table 90). The vast majority of other surveys reported CV values of ≤ 0.50, with higher values (i.e. lower precision) occurring in surveys where fewer birds were recorded (Table 90). Corresponding values for Caledonia North plus buffer regions were generally lower (i.e. higher precision), which is anticipated to relate to the number of birds recorded (Table 90).

**Table 90** **Raw counts, unapportioned and apportioned abundance and density estimates (birds per km$^2$) of fulmars in Caledonia North, Caledonia North plus 2 km buffer and Caledonia North Survey Area during the May 2021 to April 2023 survey period. Colour gradients follow the ascending order of fulmar raw counts per season, with light yellow to orange (peak number) for the breeding season months (April to mid-September) and light blue to royal blue (peak number) for the wintering months (mid-September to March)**

| Survey | Raw count | Total unapportioned | | | | | Total apportioned | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Abundance | LCL | UCL | Precision (CV) | Density (km$^2$) | Abundance | LCL | UCL | Density (km$^2$) |
| a) | Caledonia North | | | | | | | | | |
| May-21 | 25 | 146 | 82 | 210 | 0.20 | 0.67 | 146 | 69 | 221 | 0.67 |
| Jun-21 | 21 | 124 | 53 | 201 | 0.22 | 0.57 | 124 | 36 | 213 | 0.57 |
| Jul-21 | 78 | 462 | 343 | 622 | 0.11 | 2.12 | 462 | 290 | 669 | 2.11 |
| Aug-21 | 69 | 400 | 238 | 556 | 0.12 | 1.83 | 399 | 250 | 561 | 1.83 |
| Sep-21 | 24 | 139 | 81 | 209 | 0.20 | 0.64 | 139 | 48 | 255 | 0.64 |
| Oct-21 | 1 | 6 | 1 | 18 | 1.00 | 0.03 | 6 | 1 | 18 | 0.03 |
| Nov-21 | 10 | 58 | 10 | 123 | 0.32 | 0.27 | 59 | 10 | 129 | 0.27 |
| Dec-21 | 39 | 226 | 52 | 440 | 0.16 | 1.04 | 226 | 39 | 464 | 1.03 |
| Jan-22 | 12 | 69 | 12 | 133 | 0.29 | 0.32 | 69 | 15 | 162 | 0.32 |
| Feb-22 | 12 | 65 | 32 | 92 | 0.29 | 0.30 | 65 | 22 | 113 | 0.30 |
| Mar-22 | 6 | 32 | 16 | 48 | 0.41 | 0.15 | 32 | 17 | 53 | 0.15 |
| Apr-22 | 9 | 52 | 17 | 92 | 0.33 | 0.24 | 52 | 17 | 92 | 0.24 |
| May-22 | 10 | 58 | 29 | 87 | 0.32 | 0.27 | 58 | 18 | 93 | 0.27 |
| Jun-22 | 44 | 251 | 120 | 382 | 0.15 | 1.15 | 250 | 120 | 399 | 1.14 |
| Jul-22 | 179 | 1,048 | 427 | 1,762 | 0.07 | 4.80 | 1,048 | 409 | 1,815 | 4.80 |
| Aug-22 | 25 | 144 | 75 | 231 | 0.20 | 0.66 | 144 | 72 | 236 | 0.66 |
| Sep-22 | 11 | 63 | 40 | 92 | 0.30 | 0.29 | 63 | 12 | 121 | 0.29 |
| Nov-22 | 70 | 413 | 230 | 637 | 0.12 | 1.89 | 412 | 219 | 636 | 1.89 |
| Dec-22 | 22 | 128 | 23 | 256 | 0.21 | 0.59 | 128 | 22 | 256 | 0.59 |
| Jan-23 | 9 | 52 | 17 | 104 | 0.33 | 0.24 | 52 | 13 | 121 | 0.24 |
| Feb-23 | 6 | 35 | 17 | 52 | 0.41 | 0.16 | 35 | 13 | 69 | 0.16 |
| Mar-23 | 24 | 141 | 53 | 234 | 0.20 | 0.65 | 141 | 55 | 246 | 0.65 |
| Apr-23 | 5 | 28 | 6 | 56 | 0.45 | 0.13 | 28 | 5 | 62 | 0.13 |
| b) | Caledonia North plus 2 km buffer | | | | | | | | | |
| May-21 | 44 | 252 | 154 | 337 | 0.15 | 0.67 | 252 | 138 | 360 | 0.67 |
| Jun-21 | 36 | 208 | 104 | 324 | 0.17 | 0.55 | 209 | 104 | 336 | 0.56 |
| Jul-21 | 141 | 813 | 588 | 1,026 | 0.08 | 2.17 | 813 | 524 | 1,119 | 2.16 |
| Aug-21 | 123 | 698 | 459 | 976 | 0.09 | 1.86 | 698 | 459 | 970 | 1.86 |
| Sep-21 | 29 | 165 | 97 | 250 | 0.19 | 0.44 | 165 | 74 | 279 | 0.44 |
| Oct-21 | 1 | 6 | 1 | 17 | 1.00 | 0.02 | 6 | 1 | 17 | 0.02 |
| Nov-21 | 28 | 160 | 29 | 354 | 0.19 | 0.43 | 159 | 28 | 382 | 0.42 |
| Dec-21 | 61 | 347 | 119 | 648 | 0.13 | 0.92 | 347 | 111 | 637 | 0.92 |
| Jan-22 | 27 | 153 | 51 | 267 | 0.19 | 0.41 | 154 | 49 | 306 | 0.41 |
| Feb-22 | 23 | 123 | 75 | 172 | 0.21 | 0.33 | 124 | 54 | 209 | 0.33 |
| Mar-22 | 8 | 43 | 11 | 74 | 0.35 | 0.11 | 42 | 17 | 80 | 0.11 |
| Apr-22 | 20 | 112 | 56 | 191 | 0.22 | 0.30 | 112 | 47 | 202 | 0.30 |
| May-22 | 21 | 120 | 63 | 182 | 0.22 | 0.32 | 120 | 51 | 194 | 0.32 |
| Jun-22 | 84 | 485 | 242 | 756 | 0.11 | 1.29 | 485 | 208 | 854 | 1.29 |
| Jul-22 | 287 | 1,643 | 876 | 2,444 | 0.06 | 4.38 | 1,642 | 807 | 2,513 | 4.37 |
| Aug-22 | 40 | 229 | 126 | 372 | 0.16 | 0.61 | 229 | 119 | 384 | 0.61 |
| Sep-22 | 15 | 87 | 52 | 139 | 0.26 | 0.23 | 87 | 24 | 168 | 0.23 |
| Nov-22 | 119 | 686 | 421 | 980 | 0.09 | 1.83 | 686 | 424 | 998 | 1.83 |

| Survey | Raw count | Total unapportioned | | | | | Total apportioned | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Abundance | LCL | UCL | Precision (CV) | Density (km²) | Abundance | LCL | UCL | Density (km²) |
| Dec-22 | 36 | 212 | 65 | 417 | 0.17 | 0.56 | 212 | 49 | 400 | 0.56 |
| Jan-23 | 16 | 94 | 41 | 158 | 0.25 | 0.25 | 94 | 30 | 176 | 0.25 |
| Feb-23 | 13 | 74 | 40 | 108 | 0.28 | 0.20 | 74 | 32 | 125 | 0.20 |
| Mar-23 | 32 | 186 | 70 | 319 | 0.18 | 0.50 | 186 | 69 | 330 | 0.50 |
| Apr-23 | 13 | 74 | 23 | 154 | 0.28 | 0.20 | 74 | 17 | 154 | 0.20 |
| c) | Caledonia North Survey Area | | | | | | | | | |
| May-21 | 62 | 363 | 217 | 509 | 0.13 | 0.65 | 363 | 199 | 545 | 0.65 |
| Jun-21 | 53 | 314 | 201 | 450 | 0.14 | 0.56 | 314 | 196 | 450 | 0.56 |
| Jul-21 | 215 | 1,302 | 1,042 | 1,581 | 0.07 | 2.34 | 1,302 | 914 | 1,660 | 2.34 |
| Aug-21 | 179 | 1,039 | 702 | 1,388 | 0.07 | 1.87 | 1,039 | 685 | 1,434 | 1.86 |
| Sep-21 | 54 | 315 | 199 | 473 | 0.14 | 0.57 | 315 | 164 | 520 | 0.57 |
| Oct-21 | 1 | 6 | 1 | 18 | 1.00 | 0.01 | 6 | 1 | 18 | 0.01 |
| Nov-21 | 45 | 263 | 45 | 596 | 0.15 | 0.47 | 263 | 48 | 613 | 0.47 |
| Dec-21 | 87 | 507 | 239 | 897 | 0.11 | 0.91 | 507 | 216 | 868 | 0.91 |
| Jan-22 | 37 | 214 | 116 | 313 | 0.16 | 0.38 | 214 | 104 | 365 | 0.38 |
| Feb-22 | 37 | 204 | 116 | 303 | 0.16 | 0.37 | 204 | 94 | 325 | 0.37 |
| Mar-22 | 22 | 119 | 59 | 194 | 0.21 | 0.21 | 119 | 52 | 199 | 0.21 |
| Apr-22 | 24 | 138 | 69 | 224 | 0.20 | 0.25 | 138 | 66 | 231 | 0.25 |
| May-22 | 30 | 174 | 76 | 297 | 0.18 | 0.31 | 174 | 64 | 320 | 0.31 |
| Jun-22 | 130 | 751 | 387 | 1,133 | 0.09 | 1.35 | 751 | 341 | 1260 | 1.35 |
| Jul-22 | 405 | 2,370 | 1,598 | 3,260 | 0.05 | 4.25 | 2,370 | 1,551 | 3,289 | 4.25 |
| Aug-22 | 62 | 355 | 229 | 515 | 0.13 | 0.64 | 355 | 217 | 527 | 0.64 |
| Sep-22 | 19 | 111 | 52 | 169 | 0.23 | 0.20 | 111 | 34 | 198 | 0.20 |
| Nov-22 | 167 | 985 | 655 | 1,333 | 0.08 | 1.77 | 990 | 621 | 1,384 | 1.78 |
| Dec-22 | 60 | 354 | 147 | 578 | 0.13 | 0.64 | 354 | 145 | 601 | 0.63 |
| Jan-23 | 26 | 153 | 65 | 271 | 0.20 | 0.27 | 154 | 50 | 277 | 0.28 |
| Feb-23 | 21 | 121 | 75 | 173 | 0.22 | 0.22 | 121 | 61 | 185 | 0.22 |
| Mar-23 | 55 | 323 | 123 | 540 | 0.13 | 0.58 | 328 | 130 | 566 | 0.59 |
| Apr-23 | 27 | 155 | 80 | 258 | 0.19 | 0.28 | 154 | 63 | 258 | 0.28 |

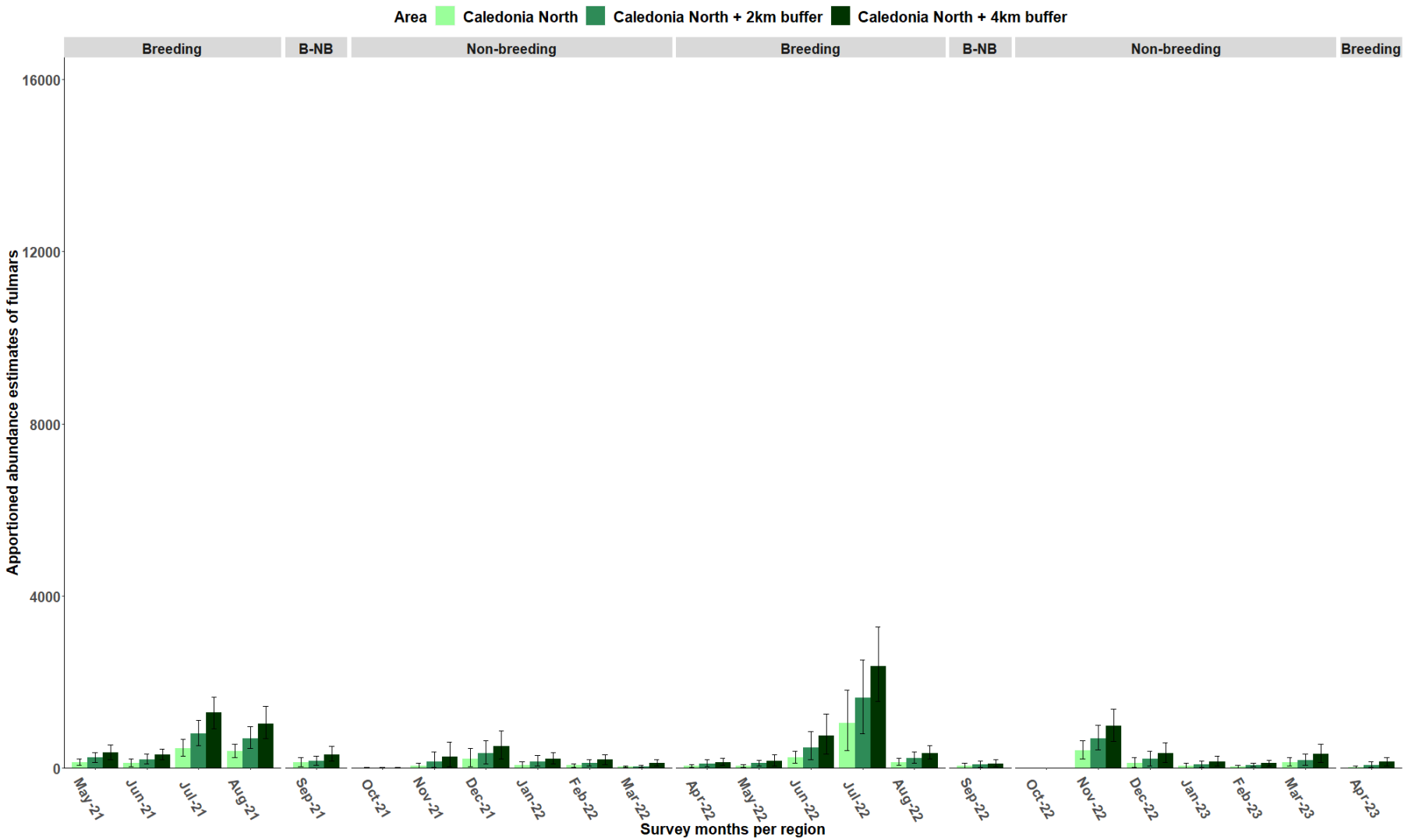



**Figure 34 Bar plot of monthly apportioned abundance estimates (with 95% confidence intervals) of the total fulmars recorded in each reporting region of Caledonia North Survey Area, during the May 2021 to April 2023 survey period. Fulmar seasonal periods are also displayed. B-NB corresponds to month split between breeding (B) and non-breeding (NB)**

### *Caledonia South*

A total of 3,511 fulmars were recorded in Caledonia South Survey Area during both years of baseline surveys (Table 10). Fulmar were recorded in all months (Table 10). Fulmars were the most abundant during the breeding season (April to mid-September). Peak of abundance was recorded in July 2022 (Table 91, Figure 35):

- 526 individuals were recorded in Caledonia South, resulting in an unapportioned mean abundance estimate of 3,068 [1,342; 5,191] and an apportioned mean abundance estimate of 3,068 [1,219; 5,640] individuals. These equated to mean density estimates of 14.59 (unapportioned) and 14.58 (apportioned) birds/km$^2$.
- 888 individuals were recorded in Caledonia South plus 2 km buffer, resulting in an unapportioned mean abundance estimate of 5,138 [2,291; 8,615] and an apportioned abundance estimate of 5,138 [2,100; 8,713] individuals. These equated to mean density estimates of 14.29 (unapportioned) and 14.28 (apportioned) birds/km$^2$.
- 1,441 individuals were recorded in Caledonia South Survey Area, resulting in an unapportioned mean abundance estimate of 8,343 [3,300; 14,144] and an apportioned abundance estimate of 8,343 [2,976; 14,590] individuals. These equated to mean density estimates of 15.64 (unapportioned) and 15.63 (apportioned) birds/km$^2$.

During the breeding seasons covered by the baseline surveys, very obvious peaks in fulmar abundance were recorded in July 2021 and 2022, with relatively consistent, and considerably lower numbers, recorded in other breeding season surveys. The peak mean abundance of fulmar across Caledonia South Survey Area was around 30% to 50% (depending on the reporting region considered) greater than the next highest mean abundance recorded, in July 2021. Mean abundances in the ten other surveys during the breeding seasons covered were 86% to 99% lower than the peak mean abundance. The data indicate that whilst larger numbers of fulmar were present within the Caledonia South Survey Area at a specific time within both breeding seasons covered by the baseline surveys (i.e. July), they were present in much lower numbers during the remainder of the breeding seasons covered by the baseline surveys.

During the non-breeding season (mid-September to March), fulmars were only recorded in higher numbers in November, with a peak in November 2021 in Caledonia South and Caledonia South plus 2 km buffer and in November 2022 in Caledonia South Survey Area (Table 91, Figure 35):

- 112 individuals were recorded in Caledonia South in November 2021, resulting in an unapportioned mean abundance estimate of 645 [112; 1,722] and apportioned abundance estimate of 646 [112; 1,722] individuals. Both equated to a mean density estimate of 3.07 birds/km$^2$.
- 127 individuals were recorded in Caledonia South plus 2 km buffer in November 2021, resulting in an unapportioned mean abundance estimate of 727 [127; 1,826] and apportioned abundance estimate of 727 [163; 1,849] individuals. Both equated to a mean density estimate of 2.02 birds/km$^2$.
- 140 individuals were recorded in Caledonia South Survey Area in November 2022, resulting in an unapportioned mean abundance estimate of 819 [602; 988] and apportioned abundance estimate of 824 [576; 1,044] individuals. Both equated to a mean density estimate of 1.54 birds/km$^2$.

As with breeding season mean abundances, the data indicates that during a specific period within both non-breeding seasons covered by the surveys (i.e. November, which recorded similar abundances in both survey years), fulmar were present in larger numbers than the rest of the non-breeding season, though the peaks were modest. Fulmar were present in most non-breeding season surveys in low numbers.

Good measures of precisions were calculated for most survey months (CV ≤ 0.16), with eight of the 23 baseline surveys in which fulmar was recorded within Caledonia South reporting CV values of ≤ 0.16 (Table 91). The other surveys reported CV values of ≤ 0.50, with higher values (i.e. lower precision) occurring in surveys where fewer birds were recorded (Table 91). Corresponding values for Caledonia South plus buffer regions were generally lower (i.e. higher precision), which is anticipated to relate to the number of birds recorded (Table 91).

**Table 91** **Raw counts, unapportioned and apportioned abundance and density estimates (birds per km²) of fulmars in Caledonia South, Caledonia South plus 2 km buffer and Caledonia South Survey Area during the May 2021 to April 2023 survey period. Colour gradients follow the ascending order of fulmar raw counts per season, with light yellow to orange (peak number) for the breeding season months (April to mid-September) and light blue to royal blue (peak number) for the wintering months (mid-September to March)**

| Survey | Raw count | Total unapportioned | | | | | Total apportioned | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Abundance | LCL | UCL | Precision (CV) | Density (km²) | Abundance | LCL | UCL | Density (km²) |
| a) | Caledonia South | | | | | | | | | |
| May-21 | 18 | 105 | 52 | 157 | 0.24 | 0.50 | 105 | 47 | 181 | 0.50 |
| Jun-21 | 19 | 111 | 64 | 157 | 0.23 | 0.53 | 111 | 47 | 175 | 0.53 |
| Jul-21 | 388 | 2,275 | 388 | 5,953 | 0.05 | 10.82 | 2,276 | 431 | 5,971 | 10.81 |
| Aug-21 | 69 | 398 | 312 | 473 | 0.12 | 1.89 | 398 | 293 | 520 | 1.89 |
| Sep-21 | 26 | 151 | 87 | 209 | 0.20 | 0.72 | 150 | 63 | 232 | 0.71 |
| Oct-21 | 2 | 12 | 2 | 29 | 0.71 | 0.06 | 12 | 2 | 29 | 0.06 |
| Nov-21 | 112 | 645 | 112 | 1,722 | 0.09 | 3.07 | 646 | 112 | 1,722 | 3.07 |
| Dec-21 | 46 | 267 | 174 | 342 | 0.15 | 1.27 | 267 | 182 | 348 | 1.27 |
| Jan-22 | 13 | 75 | 40 | 116 | 0.28 | 0.36 | 75 | 26 | 138 | 0.36 |
| Feb-22 | 24 | 130 | 54 | 222 | 0.20 | 0.62 | 130 | 43 | 232 | 0.62 |
| Mar-22 | 2 | 11 | 2 | 32 | 0.71 | 0.05 | 10 | 2 | 32 | 0.05 |
| Apr-22 | 39 | 225 | 39 | 495 | 0.16 | 1.07 | 225 | 39 | 513 | 1.07 |
| May-22 | 10 | 58 | 17 | 110 | 0.32 | 0.28 | 57 | 13 | 133 | 0.27 |
| Jun-22 | 52 | 301 | 156 | 486 | 0.14 | 1.43 | 301 | 145 | 498 | 1.43 |
| Jul-22 | 526 | 3,068 | 1,342 | 5,191 | 0.04 | 14.59 | 3,068 | 1,219 | 5,640 | 14.58 |
| Aug-22 | 19 | 109 | 69 | 150 | 0.23 | 0.52 | 110 | 59 | 167 | 0.52 |
| Sep-22 | 7 | 41 | 12 | 76 | 0.38 | 0.19 | 41 | 7 | 87 | 0.19 |
| Nov-22 | 57 | 334 | 293 | 381 | 0.13 | 1.59 | 339 | 272 | 425 | 1.61 |
| Dec-22 | 19 | 112 | 47 | 189 | 0.23 | 0.53 | 112 | 49 | 188 | 0.53 |
| Jan-23 | 5 | 29 | 12 | 41 | 0.45 | 0.14 | 29 | 7 | 59 | 0.14 |
| Feb-23 | 9 | 51 | 17 | 91 | 0.33 | 0.24 | 51 | 17 | 91 | 0.24 |
| Mar-23 | 25 | 145 | 81 | 214 | 0.20 | 0.69 | 151 | 59 | 272 | 0.72 |
| Apr-23 | 8 | 46 | 11 | 80 | 0.35 | 0.22 | 46 | 10 | 108 | 0.22 |
| b) | Caledonia South plus 2 km buffer | | | | | | | | | |
| May-21 | 36 | 208 | 150 | 260 | 0.17 | 0.58 | 208 | 115 | 312 | 0.58 |
| Jun-21 | 40 | 232 | 151 | 313 | 0.16 | 0.65 | 232 | 139 | 336 | 0.64 |
| Jul-21 | 535 | 3,113 | 593 | 7,639 | 0.04 | 8.66 | 3,112 | 675 | 7,634 | 8.65 |
| Aug-21 | 124 | 711 | 562 | 837 | 0.09 | 1.98 | 711 | 551 | 866 | 1.98 |
| Sep-21 | 43 | 249 | 173 | 324 | 0.15 | 0.69 | 249 | 150 | 353 | 0.69 |
| Oct-21 | 6 | 35 | 6 | 70 | 0.41 | 0.10 | 35 | 6 | 81 | 0.10 |
| Nov-21 | 127 | 727 | 127 | 1,826 | 0.09 | 2.02 | 727 | 163 | 1,849 | 2.02 |
| Dec-21 | 77 | 444 | 340 | 553 | 0.11 | 1.24 | 444 | 323 | 576 | 1.23 |
| Jan-22 | 23 | 132 | 69 | 195 | 0.21 | 0.37 | 132 | 52 | 218 | 0.37 |
| Feb-22 | 39 | 208 | 117 | 320 | 0.16 | 0.58 | 208 | 101 | 332 | 0.58 |
| Mar-22 | 6 | 32 | 6 | 63 | 0.41 | 0.09 | 31 | 6 | 64 | 0.09 |
| Apr-22 | 48 | 275 | 74 | 520 | 0.14 | 0.77 | 274 | 73 | 572 | 0.76 |

| Survey | Raw count | Total unapportioned | | | | | Total apportioned | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Abundance | LCL | UCL | Precision (CV) | Density (km²) | Abundance | LCL | UCL | Density (km²) |
| May-22 | 27 | 155 | 63 | 287 | 0.19 | 0.43 | 155 | 49 | 304 | 0.43 |
| Jun-22 | 77 | 437 | 250 | 664 | 0.11 | 1.22 | 437 | 244 | 681 | 1.21 |
| Jul-22 | 888 | 5,138 | 2,291 | 8,615 | 0.03 | 14.29 | 5,138 | 2,100 | 8,713 | 14.28 |
| Aug-22 | 40 | 229 | 166 | 309 | 0.16 | 0.64 | 228 | 97 | 394 | 0.63 |
| Sep-22 | 26 | 149 | 74 | 246 | 0.20 | 0.41 | 148 | 66 | 257 | 0.41 |
| Nov-22 | 104 | 606 | 530 | 670 | 0.10 | 1.69 | 611 | 495 | 730 | 1.70 |
| Dec-22 | 32 | 185 | 121 | 277 | 0.18 | 0.51 | 185 | 108 | 271 | 0.51 |
| Jan-23 | 12 | 69 | 40 | 98 | 0.29 | 0.19 | 68 | 31 | 115 | 0.19 |
| Feb-23 | 13 | 74 | 29 | 120 | 0.28 | 0.21 | 74 | 30 | 131 | 0.21 |
| Mar-23 | 42 | 242 | 132 | 334 | 0.15 | 0.67 | 247 | 132 | 376 | 0.69 |
| Apr-23 | 12 | 67 | 34 | 101 | 0.29 | 0.19 | 68 | 12 | 129 | 0.19 |
| c) | Caledonia South Survey Area | | | | | | | | | |
| May-21 | 46 | 267 | 186 | 342 | 0.15 | 0.50 | 267 | 150 | 388 | 0.50 |
| Jun-21 | 75 | 436 | 314 | 593 | 0.12 | 0.82 | 436 | 262 | 634 | 0.82 |
| Jul-21 | 673 | 4,042 | 1,051 | 8,804 | 0.04 | 7.58 | 4,042 | 973 | 8,900 | 7.57 |
| Aug-21 | 178 | 1,024 | 765 | 1,237 | 0.07 | 1.92 | 1,024 | 759 | 1,259 | 1.92 |
| Sep-21 | 96 | 557 | 412 | 714 | 0.10 | 1.04 | 557 | 331 | 790 | 1.04 |
| Oct-21 | 11 | 64 | 12 | 128 | 0.30 | 0.12 | 64 | 13 | 139 | 0.12 |
| Nov-21 | 136 | 782 | 161 | 1,880 | 0.09 | 1.47 | 782 | 169 | 1,909 | 1.47 |
| Dec-21 | 125 | 723 | 521 | 920 | 0.09 | 1.36 | 723 | 497 | 925 | 1.35 |
| Jan-22 | 31 | 179 | 92 | 265 | 0.18 | 0.34 | 179 | 81 | 294 | 0.34 |
| Feb-22 | 56 | 304 | 190 | 440 | 0.13 | 0.57 | 304 | 163 | 462 | 0.57 |
| Mar-22 | 10 | 54 | 27 | 91 | 0.32 | 0.10 | 54 | 18 | 97 | 0.10 |
| Apr-22 | 56 | 321 | 109 | 590 | 0.13 | 0.60 | 321 | 105 | 596 | 0.60 |
| May-22 | 31 | 178 | 86 | 310 | 0.18 | 0.33 | 178 | 63 | 327 | 0.33 |
| Jun-22 | 109 | 631 | 405 | 886 | 0.10 | 1.18 | 632 | 383 | 898 | 1.18 |
| Jul-22 | 1,441 | 8,343 | 3,300 | 14,144 | 0.03 | 15.64 | 8,343 | 2,976 | 14,590 | 15.63 |
| Aug-22 | 76 | 436 | 310 | 585 | 0.11 | 0.82 | 436 | 235 | 677 | 0.82 |
| Sep-22 | 38 | 222 | 117 | 344 | 0.16 | 0.42 | 222 | 105 | 362 | 0.42 |
| Oct-22 | 4 | 23 | 4 | 59 | 0.50 | 0.04 | 24 | 4 | 70 | 0.04 |
| Nov-22 | 140 | 819 | 602 | 988 | 0.08 | 1.54 | 824 | 576 | 1,044 | 1.54 |
| Dec-22 | 52 | 306 | 194 | 460 | 0.14 | 0.57 | 306 | 183 | 460 | 0.57 |
| Jan-23 | 36 | 211 | 135 | 304 | 0.17 | 0.40 | 211 | 111 | 310 | 0.40 |
| Feb-23 | 22 | 127 | 69 | 196 | 0.21 | 0.24 | 127 | 58 | 214 | 0.24 |
| Mar-23 | 54 | 315 | 181 | 455 | 0.14 | 0.59 | 320 | 165 | 491 | 0.60 |
| Apr-23 | 15 | 86 | 40 | 137 | 0.26 | 0.16 | 86 | 18 | 166 | 0.16 |

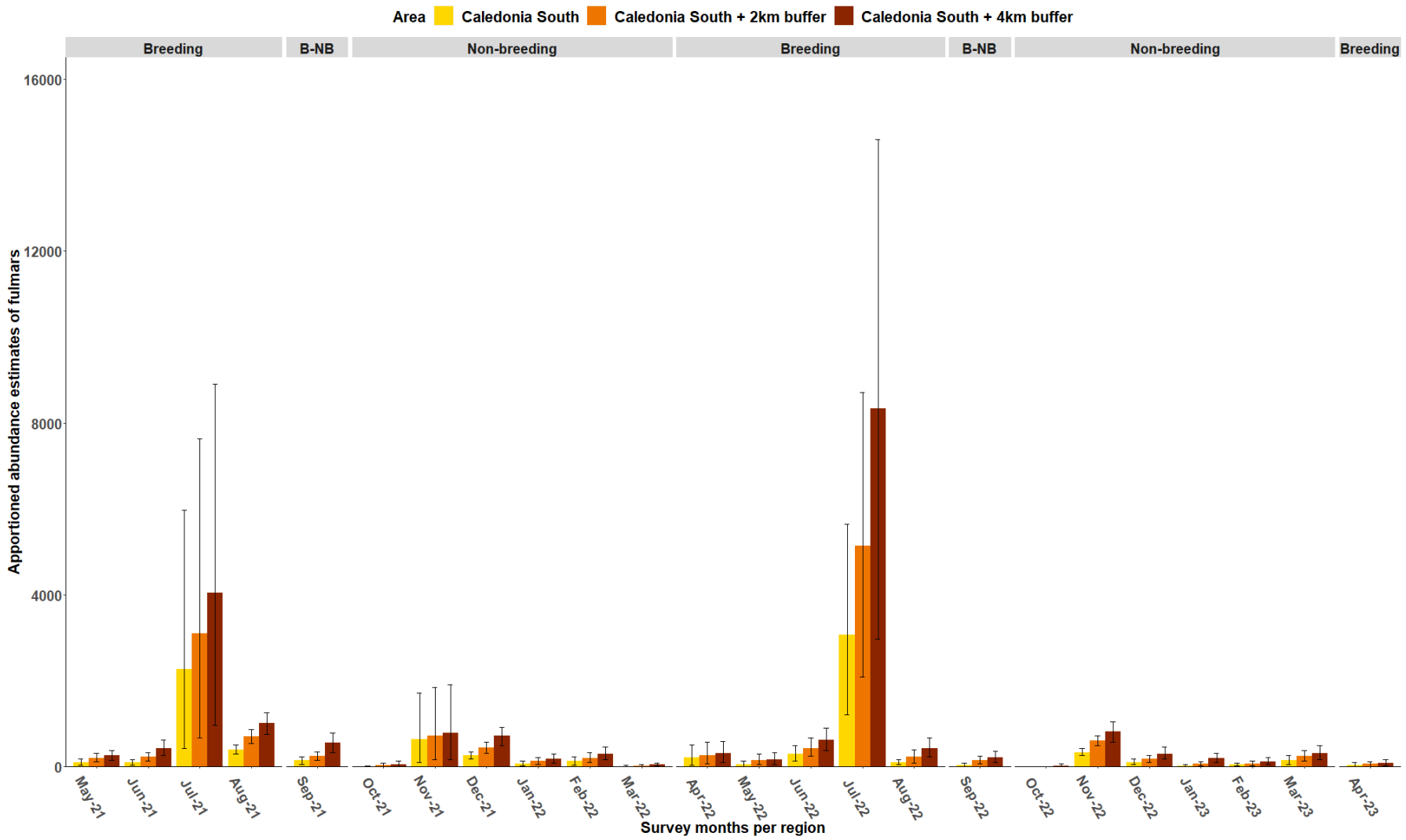



**Figure 35 Bar plot of monthly apportioned abundance estimates (with 95% confidence intervals) of the total fulmars recorded in each reporting region of Caledonia South Survey Area, during the May 2021 to April 2023 survey period. Fulmar seasonal periods are also displayed. B-NB corresponds to month split between breeding (B) and non-breeding (NB)**

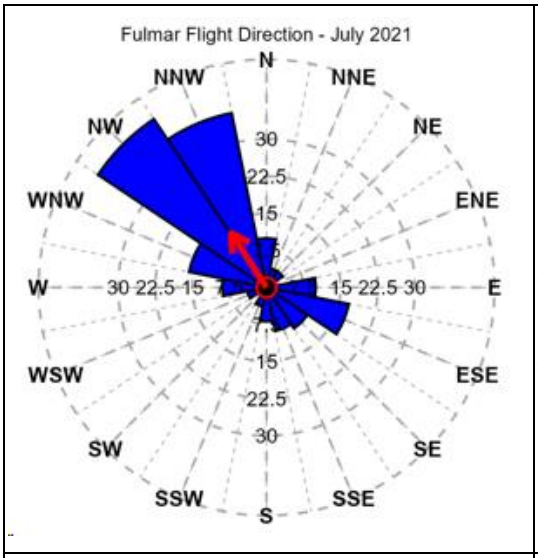
### *ii. Distribution and behaviour*

Maps of distribution are shown in Appendix 4: Figures A4.220-243. Overall, fulmars displayed no discernible distribution pattern. However, they were predominantly recorded in the southeast of the Survey Area in October 2021 (Figure A4.225) and displayed hotspots in the north and the southeast of the Survey Area in November 2021 (Figure A4.226). Only two individuals were recorded in October 2022, both in the southeast of Caledonia South Buffer Zone towards its outer boundary (Figure A4.237).

Significant predominant direction of flight was recorded in:

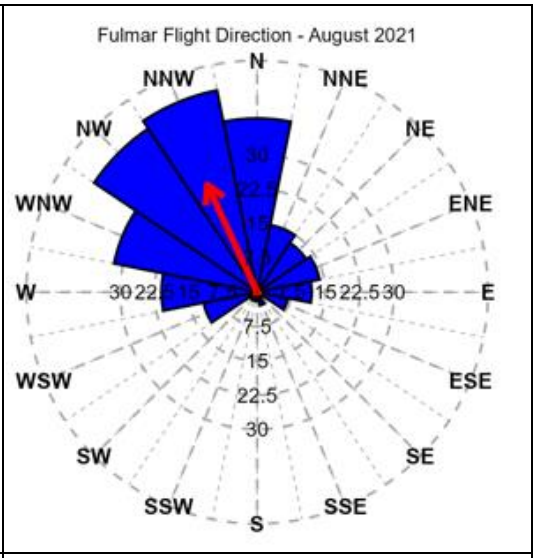
- **June**
  - 2022 north-northeast (Figure 36h)
- **July**
  - 2021 northwest (Figure 36a)
  - 2022 south-southeast (Figure 36i)
- **August**
  - 2021 north-northwest (Figure 36b)
  - 2022 south (Figure 36j)
- **November**
  - 2022 southeast (Figure 36k)
- **December**
  - 2021 south (Figure 36c)
  - 2022 south (Figure 36l)
- **January**
  - 2022 west-southwest (Figure 36d)
  - 2023 south-southeast (Figure 36m)
- **February**
  - 2022 southeast (Figure 36e)
  - 2023 east (Figure 36n)
- **March**
  - 2022 east-northeast (Figure 36f)
  - 2023 north-northeast (Figure 36o)
- **April**
  - 2022 northeast (Figure 36g)
  - 2023 east-southeast (Figure 36p)

As very few birds were recorded in flight in other surveys, they were too infrequent to determine any preference in flight direction (Appendix 5, Figure A5.23).



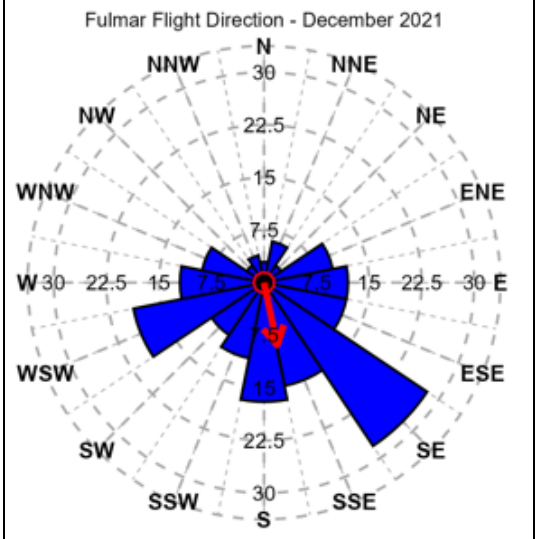

| | |
|---|---|
| Number of Observations | 185 |
| Mean Vector (μ) | 327.768 |
| Length of Mean Vector (r) | 0.319 |
| Rayleigh Test (Z) | 18.823 |
| Rayleigh Test (p) | <0.001 |

**a July 2021**



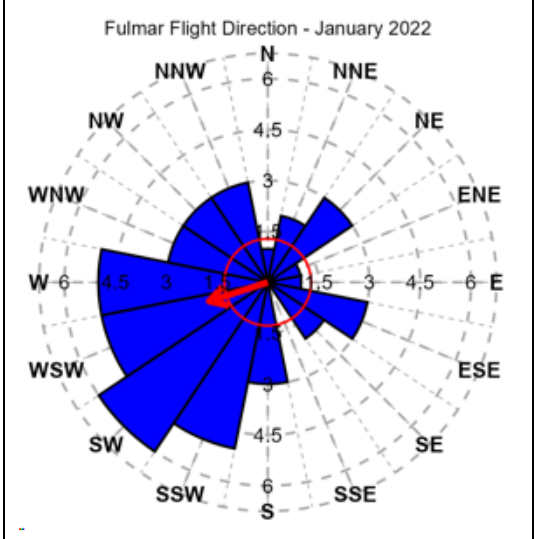

| | |
|---|---|
| Number of Observations | 262 |
| Mean Vector (μ) | 335.478 |
| Length of Mean Vector (r) | 0.574 |
| Rayleigh Test (Z) | 86.434 |
| Rayleigh Test (p) | <0.001 |

**b August 2021**



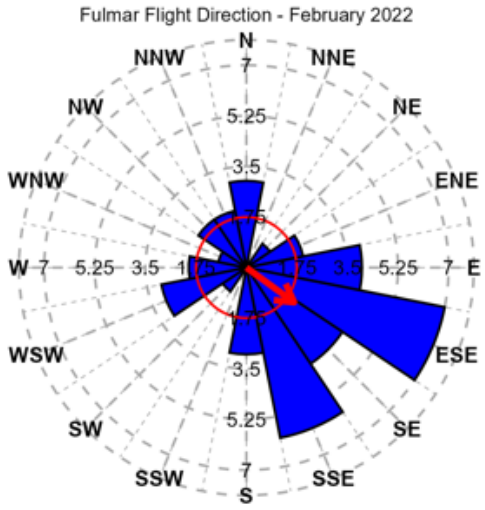

| | |
|---|---|
| Number of Observations | 173 |
| Mean Vector (μ) | 168.743 |
| Length of Mean Vector (r) | 0.324 |
| Rayleigh Test (Z) | 18.139 |
| Rayleigh Test (p) | <0.001 |

**c December 2021**



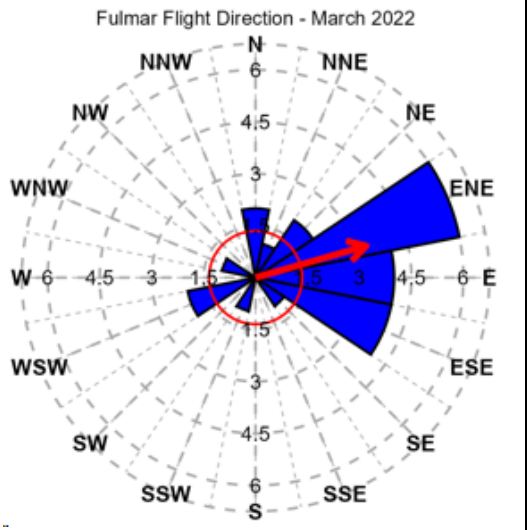

| | |
|---|---|
| Number of Observations | 46 |
| Mean Vector (μ) | 252.731 |
| Length of Mean Vector (r) | 0.303 |
| Rayleigh Test (Z) | 4.224 |
| Rayleigh Test (p) | 0.014 |

**d January 2022**



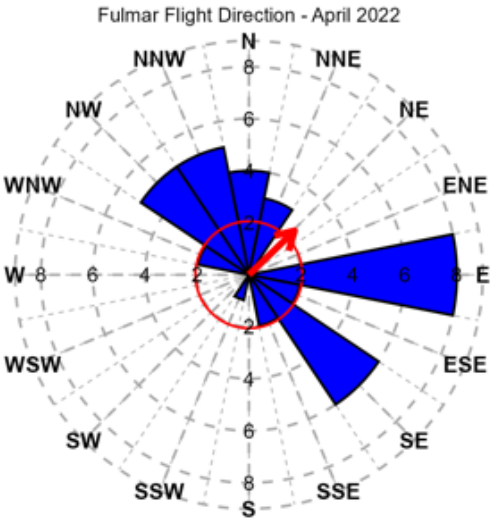

| | |
|---|---|
| Number of Observations | 41 |
| Mean Vector (μ) | 126.390 |
| Length of Mean Vector (r) | 0.291 |
| Rayleigh Test (Z) | 3.480 |
| Rayleigh Test (p) | 0.030 |

**e February 2022**



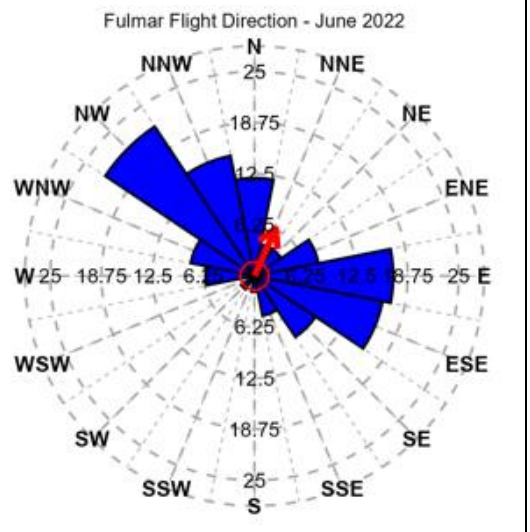

| | |
|---|---|
| Number of Observations | 24 |
| Mean Vector (μ) | 74.892 |
| Length of Mean Vector (r) | 0.554 |
| Rayleigh Test (Z) | 7.353 |
| Rayleigh Test (p) | <0.001 |

**f March 2022**



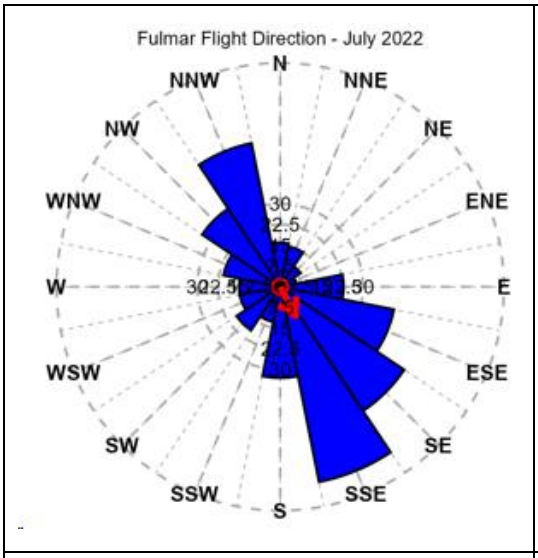

| | |
|---|---|
| Number of Observations | 38 |
| Mean Vector (μ) | 46.196 |
| Length of Mean Vector (r) | 0.305 |
| Rayleigh Test (Z) | 3.530 |
| Rayleigh Test (p) | 0.028 |

**g April 2022**



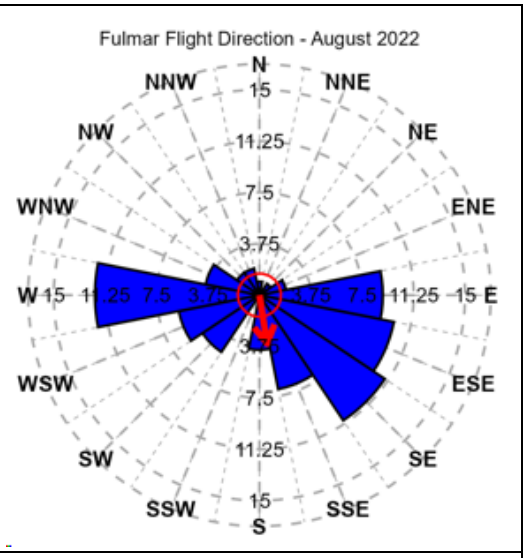

| | |
|---|---|
| Number of Observations | 130 |
| Mean Vector (μ) | 24.238 |
| Length of Mean Vector (r) | 0.287 |
| Rayleigh Test (Z) | 10.740 |
| Rayleigh Test (p) | <0.001 |

**h June 2022**



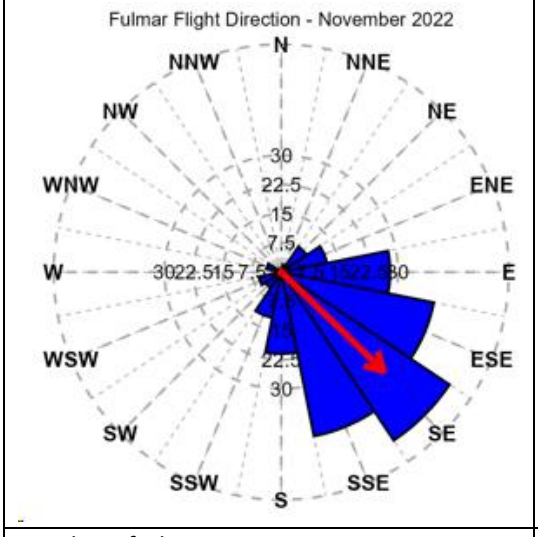

| | |
|---|---|
| Number of Observations | 440 |
| Mean Vector (μ) | 152.648 |
| Length of Mean Vector (r) | 0.165 |
| Rayleigh Test (Z) | 11.968 |
| Rayleigh Test (p) | <0.001 |

**i July 2022**



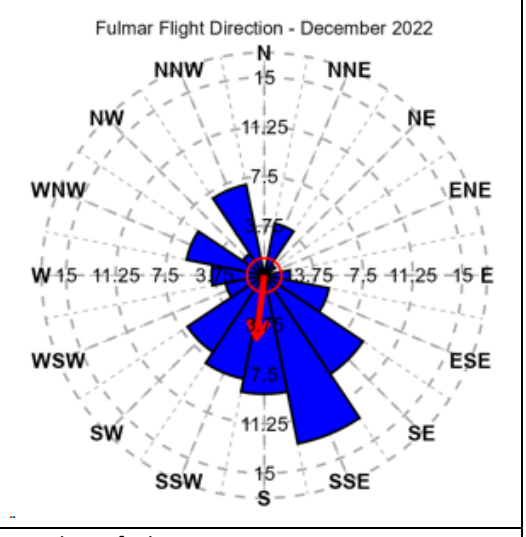

| | |
|---|---|
| Number of Observations | 76 |
| Mean Vector (μ) | 171.359 |
| Length of Mean Vector (r) | 0.298 |
| Rayleigh Test (Z) | 6.765 |
| Rayleigh Test (p) | 0.001 |

**j August 2022**



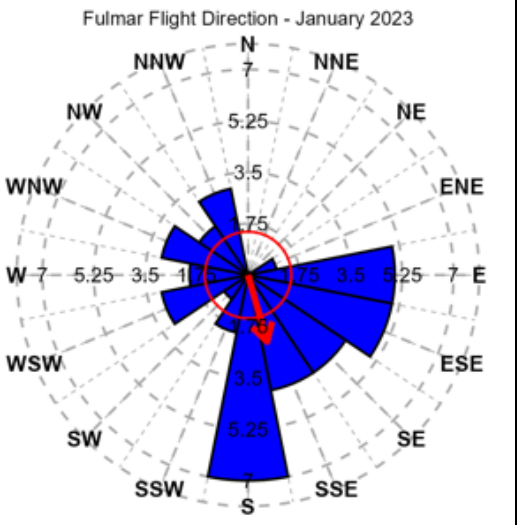

| | |
|---|---|
| Number of Observations | 234 |
| Mean Vector (μ) | 134.555 |
| Length of Mean Vector (r) | 0.702 |
| Rayleigh Test (Z) | 115.160 |
| Rayleigh Test (p) | <0.001 |

**k November 2022**



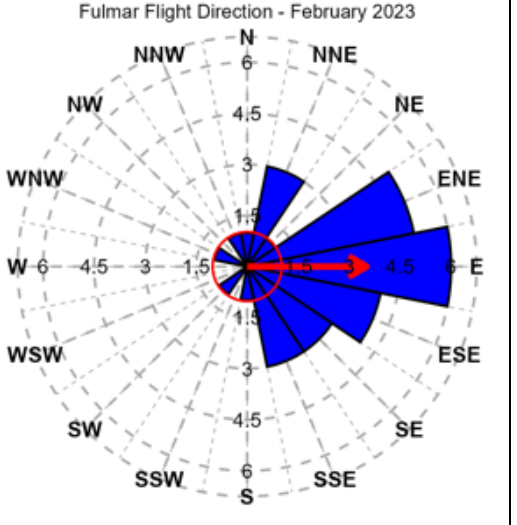

| | |
|---|---|
| Number of Observations | 80 |
| Mean Vector (μ) | 187.842 |
| Length of Mean Vector (r) | 0.368 |
| Rayleigh Test (Z) | 10.814 |
| Rayleigh Test (p) | <0.001 |

**l December 2022**



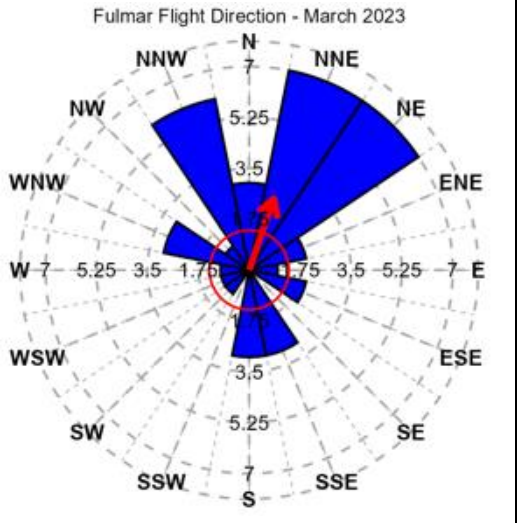

| | |
|---|---|
| Number of Observations | 42 |
| Mean Vector (μ) | 164.798 |
| Length of Mean Vector (r) | 0.336 |
| Rayleigh Test (Z) | 4.752 |
| Rayleigh Test (p) | 0.008 |

**m January 2023**



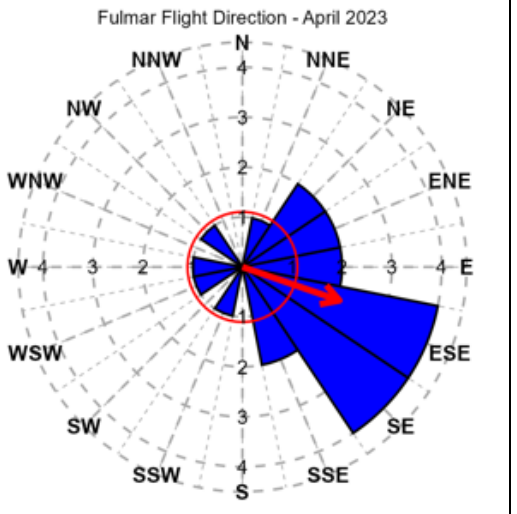

| | |
|---|---|
| Number of Observations | 30 |
| Mean Vector (μ) | 90.965 |
| Length of Mean Vector (r) | 0.584 |
| Rayleigh Test (Z) | 10.239 |
| Rayleigh Test (p) | <0.001 |

**n February 2023**




| | |
|---|---|
| Number of Observations | 41 |
| Mean Vector (μ) | 19.539 |
| Length of Mean Vector (r) | 0.372 |
| Rayleigh Test (Z) | 5.674 |
| Rayleigh Test (p) | 0.003 |

**o March 2023**




| | |
|---|---|
| Number of Observations | 21 |
| Mean Vector (μ) | 109.590 |
| Length of Mean Vector (r) | 0.515 |
| Rayleigh Test (Z) | 5.560 |
| Rayleigh Test (p) | 0.003 |

**p April 2023**

**Figure 36 Summary of flight direction of fulmars within surveys where a significant flight direction was recorded during the May 2021 to April 2023 survey period**

## 4.27 Unidentified fulmar and / or gull species

### *i. Abundance and density estimates*

Three unidentified fulmar and / or gulls were recorded in the Survey Area during the second year of the baseline surveys, two in November 2022 and a single individual in March 2023 (Table 8, Table 92). Two were recorded in Caledonia North Survey Area, a single individual in each month of November 2022 and March 2023 (Table 93). Two individuals were also recorded in Caledonia South, a single individual recorded in each month of November 2022 and March 2023 (Table 94). Abundance and density estimates were therefore low in all reporting regions (Table 92 to Table 94).

**Table 92 Raw counts, unapportioned abundance and density estimates (birds per km²) of fulmar and / or gull species in Caledonia OWF, Caledonia OWF plus 2 km buffer and the Survey Area during the May 2021 to April 2023 survey period**

| Survey | Raw count | Total unapportioned | | | | |
|---|---|---|---|---|---|---|
| | | Abundance | LCL | UCL | Precision (CV) | Density (km²) |
| **a) Caledonia OWF** | | | | | | |
| **Nov-22** | 1 | 6 | 1 | 18 | 1.00 | 0.01 |
| **Mar-23** | 1 | 6 | 1 | 18 | 1.00 | 0.01 |
| **b) Caledonia OWF plus 2 km buffer** | | | | | | |
| **Nov-22** | 1 | 6 | 1 | 17 | 1.00 | 0.01 |
| **Mar-23** | 1 | 6 | 1 | 17 | 1.00 | 0.01 |
| **c) Survey Area** | | | | | | |
| **Nov-22** | 2 | 12 | 2 | 29 | 0.71 | 0.01 |
| **Mar-23** | 1 | 6 | 1 | 18 | 1.00 | 0.01 |

**Table 93 Raw counts, unapportioned abundance and density estimates (birds per km²) of fulmar and / or gull species in Caledonia North, Caledonia North plus 2 km buffer and Caledonia North Survey Area during the May 2021 to April 2023 survey period**

| Survey | Raw count | Total unapportioned | | | | |
|---|---|---|---|---|---|---|
| | | Abundance | LCL | UCL | Precision (CV) | Density (km²) |
| **a) Caledonia North** | | | | | | |
| None recorded | | | | | | |
| **b) Caledonia North plus 2 km buffer** | | | | | | |
| None recorded | | | | | | |
| **c) Caledonia North Survey Area** | | | | | | |
| **Nov-22** | 1 | 6 | 1 | 18 | 1.00 | 0.01 |
| **Mar-23** | 1 | 6 | 1 | 18 | 1.00 | 0.01 |

**Table 94 Raw counts, unapportioned abundance and density estimates (birds per km²) of fulmar and / or gull species in Caledonia South, Caledonia South plus 2 km buffer and Caledonia South Survey Area during the May 2021 to April 2023 survey period**

| Survey | Raw count | Total unapportioned | | | | |
|---|---|---|---|---|---|---|
| | | Abundance | LCL | UCL | Precision (CV) | Density (km²) |
| **a) Caledonia South** | | | | | | |
| **Nov-23** | 1 | 6 | 1 | 18 | 1.00 | 0.03 |
| **Mar-23** | 1 | 6 | 1 | 17 | 1.00 | 0.03 |
| **b) Caledonia South plus 2 km buffer** | | | | | | |
| **Nov-22** | 1 | 6 | 1 | 17 | 1.00 | 0.02 |
| **Mar-23** | 1 | 6 | 1 | 17 | 1.00 | 0.02 |
| **c) Caledonia South Survey Area** | | | | | | |
| **Nov-22** | 1 | 6 | 1 | 18 | 1.00 | 0.01 |
| **Mar-23** | 1 | 6 | 1 | 17 | 1.00 | 0.01 |

### *ii. Distribution and behaviour*

Fulmar and / or gulls were sporadically recorded (Appendix 4, Figure A4.244-245). In November 2022, one individual was recorded in the north of Caledonia North Buffer Zone while the other was recorded in the centre of Caledonia South (Figure A4.244). In March 2023, the individual was recorded in the western parts of Caledonia South towards the western boundary with its Buffer Zone (Figure A4.245).

As very few birds were recorded in flight, they were too infrequent to determine any preference in flight direction (Appendix 5, Figure A5.24).

## 4.28 Sooty shearwater

### *i. Abundance and density estimates*

A single sooty shearwater was recorded in Caledonia OWF in September, specifically in Caledonia South, which resulted in very low abundance and density estimates (Table 8, Table 95 to Table 97).

Measures of precisions were high, which is likely related to the low numbers of individuals recorded in each region (Table 95 to Table 97). The low precision is reflected in the wide 95% confidence intervals for this species.

**Table 95 Raw counts, unapportioned and apportioned abundance and density estimates (birds per km$^2$) of sooty shearwaters in Caledonia OWF, Caledonia OWF plus 2 km buffer and the Survey Area during the May 2021 to April 2023 survey period**

| Survey | Raw count | Total unapportioned | | | | | Total apportioned | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Abundance | LCL | UCL | Precision (CV) | Density (km$^2$) | Abundance | LCL | UCL | Density (km$^2$) |
| **a) Caledonia OWF** | | | | | | | | | | |
| **Sep-21** | 1 | 6 | 1 | 17 | 1.00 | 0.01 | 6 | 1 | 17 | 0.01 |
| **b) Caledonia OWF plus 2 km buffer** | | | | | | | | | | |
| **Sep-21** | 1 | 6 | 1 | 17 | 1.00 | 0.01 | 6 | 1 | 17 | 0.01 |
| **c) Survey Area** | | | | | | | | | | |
| **Sep-21** | 1 | 6 | 1 | 18 | 1.00 | 0.01 | 6 | 1 | 18 | 0.01 |

**Table 96 Raw counts, unapportioned and apportioned abundance and density estimates (birds per km$^2$) of sooty shearwaters in Caledonia North, Caledonia North plus 2 km buffer and Caledonia North Survey Area during the May 2021 to April 2023 survey period**

| Survey | Raw count | Total unapportioned | | | | | Total apportioned | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Abundance | LCL | UCL | Precision (CV) | Density (km$^2$) | Abundance | LCL | UCL | Density (km$^2$) |
| **a) Caledonia North** | | | | | | | | | | |
| None recorded | | | | | | | | | | |
| **b) Caledonia North plus 2 km buffer** | | | | | | | | | | |
| None recorded | | | | | | | | | | |
| **c) Caledonia North Survey Area** | | | | | | | | | | |
| None recorded | | | | | | | | | | |

**Table 97 Raw counts, unapportioned and apportioned abundance and density estimates (birds per km$^2$) of sooty shearwaters in Caledonia South, Caledonia South plus 2 km buffer and Caledonia South Survey Area during the May 2021 to April 2023 survey period**

| Survey | Raw count | Total unapportioned | | | | | Total apportioned | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Abundance | LCL | UCL | Precision (CV) | Density (km$^2$) | Abundance | LCL | UCL | Density (km$^2$) |
| **a) Caledonia South** | | | | | | | | | | |
| **Sep-21** | 1 | 6 | 1 | 17 | 1.00 | 0.03 | 6 | 1 | 17 | 0.03 |

| Survey | Raw count | Total unapportioned | | | | | Total apportioned | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Abundance | LCL | UCL | Precision (CV) | Density (km²) | Abundance | LCL | UCL | Density (km²) |
| **b) Caledonia South plus 2 km buffer** | | | | | | | | | | |
| **Sep-21** | 1 | 6 | 1 | 17 | 1.00 | 0.02 | 6 | 1 | 17 | 0.02 |
| **c) Caledonia South Survey Area** | | | | | | | | | | |
| **Sep-21** | 1 | 6 | 1 | 17 | 1.00 | 0.01 | 6 | 1 | 17 | 0.01 |

#### *ii. Distribution and behaviour*

As only a single sooty shearwater was recorded in Caledonia South in September 2021 (Appendix 4, Figure A4.246).

As only one bird was recorded in flight, they were too infrequent to determine any preference in flight direction (Appendix 5, Figure A5.25).

### 4.29 Manx shearwater

#### *i. Abundance and density estimates*

A total of 28 Manx shearwaters were recorded in the Survey Area during both years of baseline surveys (Table 8). Manx shearwaters were recorded in May to July 2021, and May 2022 (Table 8, Table 98). In the Survey Area, a peak of 15 Manx shearwaters were recorded in June 2021, which resulted in an unapportioned mean abundance estimate of 88 [15; 235] and an apportioned mean abundance estimate of 89 [15; 239] individuals (Table 98). Both equated to a mean density estimate of 0.10 birds/km² (Table 98).

Manx shearwaters were only recorded during the breeding season (April to mid-October).

CV values were high, indicating low precision in the mean abundance estimates (Table 98). This is likely related to the low numbers of individuals recorded in each region (Table 98). This is reflected in the wide 95% confidence intervals recorded for this species (Table 98).

**Table 98 Raw counts, unapportioned and apportioned abundance and density estimates (birds per km²) of Manx shearwaters in Caledonia OWF, Caledonia OWF plus 2 km buffer and the Survey Area during the May 2021 to April 2023 survey period**

| Survey | Raw count | Total unapportioned | | | | | Total apportioned | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Abundance | LCL | UCL | Precision (CV) | Density (km²) | Abundance | LCL | UCL | Density (km²) |
| **a) Caledonia OWF** | | | | | | | | | | |
| **Jun-21** | 2 | 12 | 2 | 29 | 0.71 | 0.03 | 12 | 2 | 30 | 0.03 |
| **Jul-21** | 2 | 12 | 2 | 29 | 0.71 | 0.03 | 12 | 2 | 29 | 0.03 |
| **May-22** | 8 | 46 | 8 | 116 | 0.35 | 0.11 | 47 | 8 | 133 | 0.11 |
| **b) Caledonia OWF plus 2 km buffer** | | | | | | | | | | |
| **Jun-21** | 9 | 52 | 9 | 122 | 0.33 | 0.08 | 54 | 9 | 149 | 0.08 |
| **Jul-21** | 3 | 17 | 6 | 35 | 0.58 | 0.03 | 17 | 6 | 35 | 0.03 |
| **May-22** | 8 | 46 | 8 | 120 | 0.35 | 0.07 | 45 | 8 | 132 | 0.07 |
| **c) Survey Area** | | | | | | | | | | |
| **May-21** | 1 | 6 | 1 | 18 | 1.00 | 0.01 | 6 | 1 | 18 | 0.01 |
| **Jun-21** | 15 | 88 | 15 | 235 | 0.26 | 0.10 | 89 | 15 | 239 | 0.10 |
| **Jul-21** | 3 | 18 | 6 | 36 | 0.58 | 0.02 | 18 | 3 | 36 | 0.02 |
| **May-22** | 9 | 52 | 9 | 134 | 0.33 | 0.06 | 52 | 9 | 140 | 0.06 |

In Caledonia North Survey Area, numbers recorded were low, therefore abundance and density estimates were low (Table 99). In Caledonia South Survey Area, a peak of 15 Manx shearwaters was recorded in June 2021 (Table 99). This resulted in an unapportioned mean abundance estimate of 87 [15; 232] and an apportioned mean abundance estimate of 88 [15; 242] individuals (Table 100). Both equated to a mean density estimate of 0.16 birds/km$^2$ (Table 100).

CV values were high, indicating low precision in the mean abundance estimates (Table 99, Table 100). This is likely related to the low numbers of individuals recorded in each region (Table 99, Table 100). This is reflected in the wide 95% confidence intervals recorded for this species (Table 99, Table 100).

**Table 99 Raw counts, unapportioned and apportioned abundance and density estimates (birds per km$^2$) of Manx shearwaters in Caledonia North, Caledonia North plus 2 km buffer and Caledonia North Survey Area during the May 2021 to April 2023 survey period**

| Survey | Raw count | Total unapportioned | | | | | Total apportioned | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Abundance | LCL | UCL | Precision (CV) | Density (km$^2$) | Abundance | LCL | UCL | Density (km$^2$) |
| **a) Caledonia North** | | | | | | | | | | |
| **Jul-21** | 1 | 6 | 1 | 18 | 1.00 | 0.03 | 6 | 1 | 18 | 0.03 |
| **May-22** | 2 | 12 | 2 | 23 | 0.71 | 0.05 | 12 | 2 | 23 | 0.05 |
| **b) Caledonia North plus 2 km buffer** | | | | | | | | | | |
| **Jul-21** | 1 | 6 | 1 | 17 | 1.00 | 0.02 | 6 | 1 | 17 | 0.02 |
| **May-22** | 2 | 11 | 2 | 28 | 0.71 | 0.03 | 11 | 2 | 28 | 0.03 |
| **c) Caledonia North Survey Area** | | | | | | | | | | |
| **Jun-21** | 1 | 6 | 1 | 18 | 1.00 | 0.01 | 6 | 1 | 18 | 0.01 |
| **Jul-21** | 1 | 6 | 1 | 18 | 1.00 | 0.01 | 6 | 1 | 18 | 0.01 |
| **May-22** | 3 | 17 | 6 | 35 | 0.58 | 0.03 | 17 | 3 | 35 | 0.03 |

**Table 100 Raw counts, unapportioned and apportioned abundance and density estimates (birds per km$^2$) of Manx shearwaters in Caledonia South, Caledonia South plus 2 km buffer and Caledonia South Survey Area during the May 2021 to April 2023 survey period**

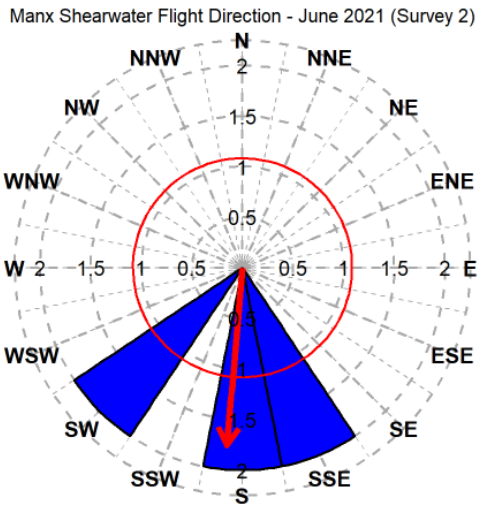
| Survey | Raw count | Total unapportioned | | | | | Total apportioned | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Abundance | LCL | UCL | Precision (CV) | Density (km$^2$) | Abundance | LCL | UCL | Density (km$^2$) |
| **a) Caledonia South** | | | | | | | | | | |
| **Jun-21** | 2 | 12 | 2 | 29 | 0.71 | 0.06 | 12 | 2 | 29 | 0.06 |
| **Jul-21** | 1 | 6 | 1 | 18 | 1.00 | 0.03 | 6 | 1 | 18 | 0.03 |
| **May-22** | 6 | 35 | 6 | 104 | 0.41 | 0.17 | 35 | 6 | 104 | 0.17 |
| **Aug-22** | - | - | - | - | - | - | 6 | 1 | 17 | 0.03 |
| **b) Caledonia South plus 2 km buffer** | | | | | | | | | | |
| **Jun-21** | 9 | 52 | 9 | 122 | 0.33 | 0.14 | 54 | 10 | 149 | 0.15 |
| **Jul-21** | 2 | 12 | 2 | 29 | 0.71 | 0.03 | 12 | 2 | 29 | 0.03 |
| **May-22** | 6 | 34 | 6 | 103 | 0.41 | 0.09 | 34 | 6 | 103 | 0.09 |
| **Aug-22** | - | - | - | - | - | - | 6 | 6 | 17 | 0.02 |
| **c) Caledonia South Survey Area** | | | | | | | | | | |
| **May-21** | 1 | 6 | 1 | 17 | 1.00 | 0.01 | 6 | 1 | 17 | 0.01 |
| **Jun-21** | 15 | 87 | 15 | 232 | 0.26 | 0.16 | 88 | 15 | 242 | 0.16 |
| **Jul-21** | 2 | 12 | 2 | 30 | 0.71 | 0.02 | 12 | 2 | 30 | 0.02 |
| **May-22** | 8 | 46 | 8 | 115 | 0.35 | 0.09 | 45 | 8 | 132 | 0.08 |
| **Aug-22** | - | - | - | - | - | - | 6 | 1 | 17 | 0.01 |

### *ii. Distribution and behaviour*

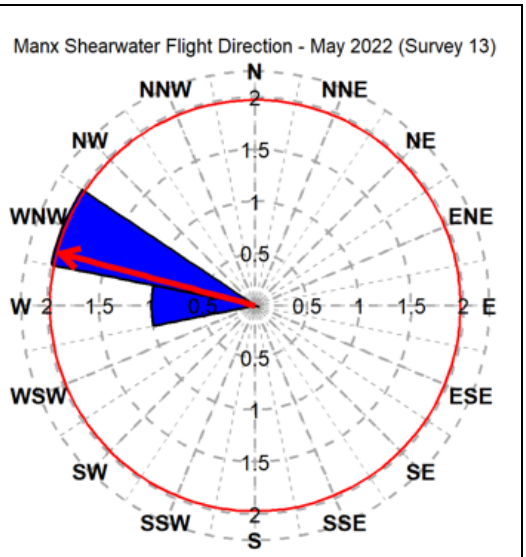
Maps of distribution are shown in Appendix 4: Figure A4.247-250. A single Manx shearwater was recorded at the southern tip of Caledonia South Buffer Zone in May 2021 (Figure A4.247). Similarly, they also largely occurred in the south of the Survey Area in June (Figure A4.248). In July 2021 and May 2022, however, they were more loosely scattered across the Survey Area (Figure A4.249-250).

All Manx shearwaters recorded in flight, were flying with significant predominant direction of flight in:

- **June**
  - 2021 south (Figure 37a)
- **May**
  - 2022 west-northwest (Figure 37b)




| Number of Observations | 6 |
|---|---|
| Mean Vector (μ) | 185.650 |
| Length of Mean Vector (r) | 0.881 |
| Rayleigh Test (Z) | 4.658 |
| Rayleigh Test (p) | 0.004 |
| **a June 2021** | |




| Number of Observations | 3 |
|---|---|
| Mean Vector (μ) | 285.782 |
| Length of Mean Vector (r) | 0.966 |
| Rayleigh Test (Z) | 2.802 |
| Rayleigh Test (p) | 0.046 |
| **b May 2022** | |

**Figure 37 Summary of flight direction of Manx shearwaters within surveys where a significant flight direction was recorded during the May 2021 to April 2023 survey period**

## 4.30 Unidentified small shearwater species

### *i. Abundance and density estimates*

Two small shearwaters were recorded in the Survey Area, specifically in Caledonia South Survey Area, during the second year of the baseline surveys (Table 8 to Table 10). A single individual was recorded in each of August and September 2022. Abundance and density estimates were therefore very low (Table 101 and Table 103). No records of small shearwater species were made across Caledonia North Survey Area (Table 102). Small shearwater species have been used for apportioning to species level where possible.

**Table 101 Raw counts, unapportioned abundance and density estimates (birds per km²) of small shearwater species in Caledonia OWF, Caledonia OWF plus 2 km buffer and the Survey Area during the May 2021 to April 2023 survey period**

| Survey | Raw count | Total unapportioned | | | | |
|---|---|---|---|---|---|---|
| | | Abundance | LCL | UCL | Precision (CV) | Density (km²) |
| **a) Caledonia OWF** | | | | | | |
| **Aug-22** | 1 | 6 | 1 | 17 | 1.00 | 0.01 |
| **b) Caledonia OWF plus 2 km buffer** | | | | | | |
| **Aug-22** | 1 | 6 | 1 | 17 | 1.00 | 0.01 |
| **Sep-22** | 1 | 6 | 1 | 17 | 1.00 | 0.01 |
| **c) Survey Area** | | | | | | |
| **Aug-22** | 1 | 6 | 1 | 17 | 1.00 | 0.01 |
| **Sep-22** | 1 | 6 | 1 | 18 | 1.00 | 0.01 |

**Table 102 Raw counts, unapportioned abundance and density estimates (birds per km²) of small shearwater species in Caledonia North, Caledonia North plus 2 km buffer and Caledonia North Survey Area during the May 2021 to April 2023 survey period**

| Survey | Raw count | Total unapportioned | | | | |
|---|---|---|---|---|---|---|
| | | Abundance | LCL | UCL | Precision (CV) | Density (km²) |
| **a) Caledonia North** | | | | | | |
| None recorded | | | | | | |
| **b) Caledonia North plus 2 km buffer** | | | | | | |
| None recorded | | | | | | |
| **c) Caledonia North Survey Area** | | | | | | |
| None recorded | | | | | | |

**Table 103 Raw counts, unapportioned abundance and density estimates (birds per km²) of small shearwater species in Caledonia South, Caledonia South plus 2 km buffer and Caledonia South Survey Area during the May 2021 to April 2023 survey period**

| Survey | Raw count | Total unapportioned | | | | |
|---|---|---|---|---|---|---|
| | | Abundance | LCL | UCL | Precision (CV) | Density (km²) |
| **a) Caledonia South** | | | | | | |
| **Aug-22** | 1 | 6 | 1 | 17 | 1.00 | 0.03 |
| **b) Caledonia South plus 2 km buffer** | | | | | | |
| **Aug-22** | 1 | 6 | 1 | 17 | 1.00 | 0.02 |
| **Sep-22** | 1 | 6 | 1 | 17 | 1.00 | 0.02 |
| **c) Caledonia South Survey Area** | | | | | | |
| **Aug-22** | 1 | 6 | 1 | 17 | 1.00 | 0.01 |
| **Sep-22** | 1 | 6 | 1 | 18 | 1.00 | 0.01 |

### *ii. Distribution and behaviour*

Both small shearwater species were recorded in Caledonia South, with the individual recorded in August 2022 located in the west, near the boundary with the Buffer Zone (Appendix 4, Figure A4.251). In September 2022, the individual was recorded in the southwest of Caledonia South 4 km buffer (Appendix 4, Figure A4.252).

As only one bird was recorded in flight each survey, they were too infrequent to determine any preference in flight direction (Appendix 5, Figure A5.26).

## 4.31 Unidentified shearwater species

### *i. Abundance and density estimates*

A single shearwater species was recorded in the Survey Area, specifically in Caledonia South Survey Area, during the second year of the baseline surveys (Table 8 to Table 10). The single individual was recorded in September 2022, and therefore, the abundance and density estimates were very low (Table 104, Table 106). No records of shearwater species were made across Caledonia North Survey Area (Table 105). Shearwater species have been used for apportioning to species level where possible.

**Table 104 Raw counts, unapportioned abundance and density estimates (birds per km$^2$) of shearwater species in Caledonia OWF, Caledonia OWF plus 2 km buffer and the Survey Area during the May 2021 to April 2023 survey period**

| Survey | Raw count | Total unapportioned | | | | |
|---|---|---|---|---|---|---|
| | | Abundance | LCL | UCL | Precision (CV) | Density (km$^2$) |
| **a) Caledonia OWF** | | | | | | |
| None recorded | | | | | | |
| **b) Caledonia OWF plus 2 km buffer** | | | | | | |
| **Sep-22** | 1 | 6 | 1 | 17 | 1.00 | 0.01 |
| **c) Survey Area** | | | | | | |
| **Sep-22** | 1 | 6 | 1 | 18 | 1.00 | 0.01 |

**Table 105 Raw counts, unapportioned abundance and density estimates (birds per km$^2$) of shearwater species in Caledonia North, Caledonia North plus 2 km buffer and Caledonia North Survey Area during the May 2021 to April 2023 survey period**

| Survey | Raw count | Total unapportioned | | | | |
|---|---|---|---|---|---|---|
| | | Abundance | LCL | UCL | Precision (CV) | Density (km$^2$) |
| **a) Caledonia North** | | | | | | |
| None recorded | | | | | | |
| **b) Caledonia North plus 2 km buffer** | | | | | | |
| None recorded | | | | | | |
| **c) Caledonia North Survey Area** | | | | | | |
| None recorded | | | | | | |

**Table 106 Raw counts, unapportioned abundance and density estimates (birds per km$^2$) of shearwater species in Caledonia South, Caledonia South plus 2 km buffer and Caledonia South Survey Area during the May 2021 to April 2023 survey period**

| Survey | Raw count | Total unapportioned | | | | |
|---|---|---|---|---|---|---|
| | | Abundance | LCL | UCL | Precision (CV) | Density (km$^2$) |
| **a) Caledonia South** | | | | | | |
| None recorded | | | | | | |
| **b) Caledonia South plus 2 km buffer** | | | | | | |
| **Sep-22** | 1 | 6 | 1 | 17 | 1.00 | 0.02 |
| **c) Caledonia South Survey Area** | | | | | | |
| **Sep-22** | 1 | 6 | 1 | 18 | 1.00 | 0.01 |

### *ii. Distribution and behaviour*

A single shearwater species was recorded in September 2022 at the southern tip of Caledonia South Buffer Zone (Appendix 4, Figure A4.253).

## 4.32 Unidentified auk and / or shearwater species

### *i. Abundance and density estimates*

A total of 133 unidentified auk and / or shearwaters were recorded in the Survey Area during both years of baseline surveys (Table 8). Auk and / or shearwaters were only recorded in months of April to July and September (Table 8). Peak numbers were recorded in September 2022 across the Survey Area, with 74 individuals were recorded in the Survey Area, resulting in an unapportioned mean abundance estimate of 432 [74; 1,290] individuals, which equated to a mean density estimate of 0.49 birds/km$^2$ (Table 107). Auk and / or shearwaters have been used for apportioning to species level where possible.

**Table 107 Raw counts, unapportioned abundance and density estimates (birds per km$^2$) of auk and / or shearwater species in Caledonia OWF, Caledonia OWF plus 2 km buffer and the Survey Area during the May 2021 to April 2023 survey period**

| Survey | Raw count | Total unapportioned | | | | |
|---|---|---|---|---|---|---|
| | | Abundance | LCL | UCL | Precision (CV) | Density (km$^2$) |
| **a) Caledonia OWF** | | | | | | |
| **May-21** | 2 | 12 | 2 | 35 | 0.71 | 0.03 |
| **Jun-21** | 3 | 18 | 3 | 41 | 0.58 | 0.04 |
| **Jul-21** | 7 | 41 | 7 | 88 | 0.38 | 0.1 |
| **Apr-22** | 1 | 6 | 1 | 17 | 1.00 | 0.01 |
| **May-22** | 6 | 35 | 12 | 64 | 0.41 | 0.08 |
| **Jun-22** | 2 | 11 | 2 | 29 | 0.71 | 0.03 |
| **Sep-22** | 1 | 6 | 1 | 17 | 1.00 | 0.01 |
| **Mar-23** | 2 | 12 | 2 | 35 | 0.71 | 0.03 |
| **Apr-23** | 1 | 6 | 1 | 17 | 1.00 | 0.01 |
| **b) Caledonia OWF plus 2 km buffer** | | | | | | |
| **May-21** | 5 | 29 | 5 | 69 | 0.45 | 0.05 |
| **Jun-21** | 14 | 81 | 14 | 174 | 0.27 | 0.13 |
| **Jul-21** | 12 | 70 | 12 | 151 | 0.29 | 0.11 |
| **Apr-22** | 1 | 6 | 1 | 17 | 1.00 | 0.01 |
| **May-22** | 9 | 51 | 23 | 92 | 0.33 | 0.08 |
| **Jun-22** | 4 | 23 | 4 | 52 | 0.50 | 0.04 |
| **Aug-22** | 1 | 6 | 1 | 17 | 1.00 | 0.01 |
| **Sep-22** | 74 | 427 | 74 | 1,275 | 0.12 | 0.66 |
| **Mar-23** | 3 | 17 | 3 | 46 | 0.58 | 0.03 |
| **Apr-23** | 1 | 6 | 1 | 17 | 1.00 | 0.01 |
| **c) Survey Area** | | | | | | |
| **May-21** | 10 | 58 | 18 | 111 | 0.32 | 0.07 |
| **Jun-21** | 14 | 82 | 14 | 171 | 0.27 | 0.09 |
| **Jul-21** | 13 | 78 | 18 | 169 | 0.28 | 0.09 |
| **Apr-22** | 2 | 12 | 2 | 29 | 0.71 | 0.01 |
| **May-22** | 9 | 52 | 23 | 93 | 0.33 | 0.06 |
| **Jun-22** | 5 | 29 | 6 | 58 | 0.45 | 0.03 |
| **Aug-22** | 1 | 6 | 1 | 17 | 1.00 | 0.01 |
| **Sep-22** | 74 | 432 | 74 | 1,290 | 0.12 | 0.49 |
| **Mar-23** | 4 | 23 | 4 | 53 | 0.50 | 0.03 |
| **Apr-23** | 1 | 6 | 1 | 17 | 1.00 | 0.01 |

In Caledonia North Survey Area, peak numbers of auk and / or shearwaters were recorded in July 2021, with seven individuals recorded (Table 108). This resulted in an unapportioned mean abundance estimate of 42 [12; 73] individuals, which equated to a mean density estimate of 0.08 birds/km$^2$ (Table 108).

**Table 108 Raw counts, unapportioned abundance and density estimates (birds per km$^2$) of auk and / or shearwater species in Caledonia North, Caledonia North plus 2 km buffer and Caledonia North Survey Area during the May 2021 to April 2023 survey period**

| Survey | Raw count | Total unapportioned | | | | |
|---|---|---|---|---|---|---|
| | | Abundance | LCL | UCL | Precision (CV) | Density (km$^2$) |
| **a) Caledonia North** | | | | | | |
| **Jun-21** | 1 | 6 | 1 | 18 | 1.00 | 0.03 |
| **Jul-21** | 3 | 18 | 6 | 36 | 0.58 | 0.08 |
| **Apr-22** | 1 | 6 | 1 | 17 | 1.00 | 0.03 |
| **May-22** | 4 | 23 | 4 | 46 | 0.50 | 0.11 |
| **Jun-22** | 1 | 6 | 1 | 17 | 1.00 | 0.03 |
| **Sep-22** | 1 | 6 | 1 | 17 | 1.00 | 0.03 |
| **Mar-23** | 2 | 12 | 2 | 35 | 0.71 | 0.05 |
| **b) Caledonia North plus 2 km buffer** | | | | | | |
| **May-21** | 1 | 6 | 1 | 17 | 1.00 | 0.02 |
| **Jun-21** | 1 | 6 | 1 | 17 | 1.00 | 0.02 |
| **Jul-21** | 4 | 23 | 4 | 46 | 0.50 | 0.06 |
| **Apr-22** | 1 | 6 | 1 | 17 | 1.00 | 0.02 |
| **May-22** | 6 | 34 | 6 | 74 | 0.41 | 0.09 |
| **Jun-22** | 3 | 17 | 3 | 40 | 0.58 | 0.05 |
| **Aug-22** | 1 | 6 | 1 | 17 | 1.00 | 0.02 |
| **Sep-22** | 1 | 6 | 1 | 17 | 1.00 | 0.02 |
| **Mar-23** | 2 | 12 | 2 | 35 | 0.71 | 0.03 |
| **c) Caledonia North Survey Area** | | | | | | |
| **May-21** | 6 | 35 | 12 | 64 | 0.41 | 0.06 |
| **Jun-21** | 1 | 6 | 1 | 18 | 1.00 | 0.01 |
| **Jul-21** | 7 | 42 | 12 | 73 | 0.38 | 0.08 |
| **Apr-22** | 2 | 12 | 2 | 29 | 0.71 | 0.02 |
| **May-22** | 6 | 35 | 6 | 76 | 0.41 | 0.06 |
| **Jun-22** | 4 | 23 | 4 | 46 | 0.50 | 0.04 |
| **Aug-22** | 1 | 6 | 1 | 17 | 1.00 | 0.01 |
| **Sep-22** | 1 | 6 | 1 | 17 | 1.00 | 0.01 |
| **Mar-23** | 2 | 12 | 2 | 35 | 0.71 | 0.02 |

In Caledonia South Survey Area, peak numbers of auk and / or shearwaters were recorded in September 2022, with 73 individuals recorded (Table 109). This resulted in a mean abundance estimate of 426 [73; 1,278] individuals, which equated to a mean density estimate of 0.80 birds/km$^2$ (Table 109).

**Table 109 Raw counts, unapportioned abundance and density estimates (birds per km$^2$) of auk and / or shearwater species in Caledonia South, Caledonia South plus 2 km buffer and Caledonia South Survey Area during the May 2021 to April 2023 survey period**

| Survey | Raw count | Total unapportioned | | | | |
|---|---|---|---|---|---|---|
| | | Abundance | LCL | UCL | Precision (CV) | Density (km$^2$) |
| **a) Caledonia South** | | | | | | |
| **May-21** | 2 | 12 | 2 | 35 | 0.71 | 0.06 |
| **Jun-21** | 2 | 12 | 2 | 35 | 0.71 | 0.06 |
| **Jul-21** | 4 | 23 | 4 | 65 | 0.50 | 0.11 |
| **May-22** | 2 | 12 | 2 | 23 | 0.71 | 0.06 |
| **Jun-22** | 1 | 6 | 1 | 17 | 1.00 | 0.03 |
| **Apr-23** | 1 | 6 | 1 | 17 | 1.00 | 0.03 |
| **b) Caledonia South plus 2 km buffer** | | | | | | |
| **May-21** | 4 | 23 | 4 | 64 | 0.50 | 0.06 |
| **Jun-21** | 13 | 75 | 13 | 168 | 0.28 | 0.21 |

| Survey | Raw count | Total unapportioned | | | | |
|---|---|---|---|---|---|---|
| | | Abundance | LCL | UCL | Precision (CV) | Density (km$^2$) |
| **Jul-21** | 9 | 52 | 9 | 128 | 0.33 | 0.14 |
| **May-22** | 3 | 17 | 3 | 34 | 0.58 | 0.05 |
| **Jun-22** | 3 | 17 | 3 | 40 | 0.58 | 0.05 |
| **Sep-22** | 73 | 417 | 73 | 1,251 | 0.12 | 1.16 |
| **Mar-23** | 1 | 6 | 1 | 17 | 1.00 | 0.02 |
| **Apr-23** | 1 | 6 | 1 | 17 | 1.00 | 0.02 |
| **c) Caledonia South Survey Area** | | | | | | |
| **May-21** | 5 | 29 | 5 | 87 | 0.45 | 0.05 |
| **Jun-21** | 14 | 81 | 14 | 174 | 0.27 | 0.15 |
| **Jul-21** | 10 | 60 | 12 | 132 | 0.32 | 0.11 |
| **May-22** | 3 | 17 | 3 | 34 | 0.58 | 0.03 |
| **Jun-22** | 4 | 23 | 4 | 46 | 0.50 | 0.04 |
| **Sep-22** | 73 | 426 | 73 | 1,278 | 0.12 | 0.80 |
| **Mar-23** | 2 | 12 | 2 | 29 | 0.71 | 0.02 |
| **Apr-23** | 1 | 6 | 1 | 17 | 1.00 | 0.01 |

#### *ii. Distribution and behaviour*

Maps of distribution are shown in Appendix 4: Figure A4.254-263. Auk and / or shearwaters were recorded in the north and east to south of the Survey Area during May 2021, September 2022, and March 2023 (Figure A4.254, 261-262). In June 2021, they were recorded in the centre and south of the Survey Area (Figure A4.255) whereas they were more loosely distributed during July 2021, and May to June 2022 (Figure A4.256, 258-259). In April and August 2022, individuals were recorded in the northwest of the Survey Area (Figure A4.257, 260). A single individual was recorded in the northwest of Caledonia North Buffer Zone in August 2022 (Figure A4.135) while it was recorded in the east of Caledonia South in April 2023 (Figure A4.263).

As very few birds were recorded in flight, they were too infrequent to determine any preference in flight direction (Appendix 5, Figure A5.27).

### 4.33 Gannet

#### *i. Abundance and density estimates*

##### *Caledonia OWF*

A total of 1,093 gannets were recorded in the Survey Area during both years of baseline surveys (Table 8). Gannets were recorded throughout the year, being recorded in Caledonia OWF in 23 of 24 baseline surveys, and Caledonia OWF plus buffers in every survey (Table 110, Figure 38). Gannets were the most abundant during the breeding season (mid-March to September). Peak of abundance was recorded in June 2022 (Table 110, Figure 38):

- 173 individuals were recorded in Caledonia OWF, resulting in an unapportioned mean abundance estimate of 994 [224; 1,977] individuals, which equated to a mean density estimate of 2.33 birds/km$^2$.
- 225 individuals were recorded in Caledonia OWF plus 2 km buffer, resulting in an unapportioned mean abundance estimate of 1,289 [487; 2,212] individuals, which equated to a mean density estimate of 2.00 birds/km$^2$.
- 258 individuals were recorded in the Survey Area, resulting in an unapportioned mean abundance estimate of 1,493 [666; 2,448] individuals, which equated to a mean density estimate of 1.69 birds/km$^2$.

The two breeding seasons covered by the baseline survey period displayed some similarities in temporal variation in mean unapportioned gannet abundance within the Survey Area. Abundances were relatively low in the early breeding season months (April and May), with peak mean unapportioned gannet abundance occurring in June for both breeding seasons. A key difference between the 2021 and 2022 breeding seasons was the size of the June mean unapportioned abundance peak, which was considerably larger in 2022 than 2021. The following two months (July and August) recorded lower mean unapportioned gannet abundances in both 2021 and 2022, though higher than the early breeding season. In 2021, the August mean unapportioned gannet abundances were higher than July, and vice versa in 2022. Both September 2021 and September 2022 saw increases in mean unapportioned gannet abundance compared with previous months. The timing of this increased mean unapportioned abundance peak, and its continuation into the early part of the non-breeding season, suggests that the Survey Area may be a location used by post-breeding aggregations of this species, before birds leave the wider area for the non-breeding season.

The peak abundance of gannets during the breeding season (June 2022) was considerably higher than other months, with over twice the number of birds recorded in Caledonia OWF reporting regions when compared with the next most abundant month. Reductions in mean unapportioned abundance relative to the peak were between 55% to >99.5%.

During the non-breeding season (October to mid-February), gannets were particularly abundant in October 2021, which is when the peak was recorded (Table 110, Figure 38):

- 66 individuals were recorded in Caledonia OWF, resulting in an unapportioned mean abundance estimate of 386 [252; 527] individuals, which equated to a mean density estimate of 0.90 birds/km$^2$.
- 91 individuals were recorded in Caledonia OWF plus 2 km buffer, resulting in an unapportioned mean abundance estimate of 525 [375; 692] individuals, which equated to a mean density estimate of 0.82 birds/km$^2$.
- 125 individuals were recorded in the Survey Area, resulting in an unapportioned mean abundance estimate of 732 [486; 977] individuals, which equated to a mean density estimate of 0.83 birds/km$^2$.

In both non-breeding seasons covered by the baseline survey period, the only month where substantial numbers of gannets were recorded in the Survey Area was October. It is considered a reasonable assumption, based on the timing of this peak, and its relative size compared with unapportioned mean abundances in other non-breeding season surveys, that these peak mean unapportioned abundances represent post-breeding aggregations of birds (likely from multiple breeding colonies across the region). Low abundances of birds were recorded in all reporting regions for the remainder of the non-breeding season surveys. It is noteworthy that the October 2021 peak was considerably larger than the October 2022 peak.

Reductions in mean apportioned and availability bias-corrected abundance relative to the peak were between 62% to 99%, with many of the surveys recording reductions in mean abundances at the upper end of this range when compared with the peak month. This reflects the fact that the October 2021 peak (which was the overall peak mean unapportioned abundance for gannet in the non-breeding season across the baseline survey period) was very large relative to the other mean unapportioned abundances recorded for gannet during the non-breeding season in the Survey Area and reporting regions. Relatively good measures of precisions (CV ≤ 0.16) were calculated for survey month where raw counts of individuals where higher, and measures of precisions were high when raw counts of individual were low (CV > 0.16; Table 110).

This means that CV values were lowest during the middle part of the breeding season, and the late breeding season and autumn dispersal periods (Table 110). CV values were > 0.16 for the most part, with only five, seven and eight surveys of Caledonia OWF, Caledonia OWF plus 2 km buffer and the Survey Area respectively having CV values of ≤ 0.16 (Table 110). This indicates lower precision for the abundance and densities calculated for this species compared to some of the more numerous species recorded during the baseline surveys. This is reflected by the relatively large 95% confidence intervals around the mean abundance estimates for this species (Table 110).

**Table 110 Raw counts, unapportioned abundance and density estimates (birds per km$^2$) of gannets in Caledonia OWF, Caledonia OWF plus 2 km buffer and the Survey Area during the May 2021 to April 2023 survey period. Colour gradients follow the ascending order of gannet raw counts per season, with light yellow to orange (peak number) for the breeding season months (mid-March to September) and light blue to royal blue (peak number) for the wintering months (October to mid-February). No colours were attributed to the breeding site attendance period (mid-February - mid-March)**

| Survey | Raw count | Total unapportioned | | | | |
|---|---|---|---|---|---|---|
| | | Abundance | LCL | UCL | Precision (CV) | Density (km$^2$) |
| **a) Caledonia OWF** | | | | | | |
| **May-21** | 3 | 17 | 3 | 35 | 0.58 | 0.04 |
| **Jun-21** | 68 | 399 | 217 | 663 | 0.12 | 0.93 |
| **Jul-21** | 18 | 106 | 18 | 271 | 0.24 | 0.25 |
| **Aug-21** | 27 | 156 | 93 | 237 | 0.19 | 0.37 |
| **Sep-21** | 40 | 232 | 99 | 383 | 0.16 | 0.54 |
| **Oct-21** | **66** | **386** | **252** | **527** | **0.12** | **0.9** |
| **Nov-21** | 9 | 52 | 23 | 81 | 0.33 | 0.12 |
| **Dec-21** | 4 | 23 | 4 | 46 | 0.50 | 0.05 |
| **Jan-22** | 2 | 12 | 2 | 29 | 0.71 | 0.03 |
| **Feb-22** | 2 | 11 | 2 | 32 | 0.71 | 0.03 |
| **Mar-22** | 1 | 5 | 1 | 16 | 1.00 | 0.01 |
| **Apr-22** | 4 | 23 | 6 | 40 | 0.50 | 0.05 |
| **May-22** | 13 | 75 | 13 | 191 | 0.28 | 0.18 |
| **Jun-22** | **173** | **994** | **224** | **1,977** | **0.08** | **2.33** |
| **Jul-22** | 30 | 175 | 105 | 269 | 0.18 | 0.41 |
| **Aug-22** | 7 | 40 | 12 | 75 | 0.38 | 0.09 |
| **Sep-22** | 52 | 301 | 145 | 475 | 0.14 | 0.7 |
| **Oct-22** | 10 | 58 | 10 | 123 | 0.32 | 0.14 |
| **Nov-22** | 1 | 6 | 1 | 18 | 1.00 | 0.01 |
| **Dec-22** | 1 | 6 | 1 | 18 | 1.00 | 0.01 |
| **Jan-23** | 1 | 6 | 1 | 17 | 1.00 | 0.01 |
| **Feb-23** | 3 | 17 | 3 | 34 | 0.58 | 0.04 |
| **Apr-23** | 14 | 79 | 14 | 227 | 0.27 | 0.18 |
| **b) Caledonia OWF plus 2 km buffer** | | | | | | |
| **May-21** | 11 | 63 | 34 | 98 | 0.30 | 0.1 |
| **Jun-21** | 91 | 528 | 273 | 835 | 0.10 | 0.82 |
| **Jul-21** | 21 | 122 | 21 | 266 | 0.22 | 0.19 |
| **Aug-21** | 49 | 280 | 171 | 394 | 0.14 | 0.44 |
| **Sep-21** | 66 | 379 | 230 | 545 | 0.12 | 0.59 |
| **Oct-21** | **91** | **525** | **375** | **692** | **0.10** | **0.82** |
| **Nov-21** | 13 | 74 | 34 | 114 | 0.28 | 0.11 |
| **Dec-21** | 4 | 23 | 4 | 52 | 0.50 | 0.04 |
| **Jan-22** | 2 | 11 | 2 | 29 | 0.71 | 0.02 |
| **Feb-22** | 4 | 21 | 4 | 64 | 0.5 | 0.03 |

| Survey | Raw count | Total unapportioned | | | | |
|---|---|---|---|---|---|---|
| | | Abundance | LCL | UCL | Precision (CV) | Density (km²) |
| Mar-22 | 1 | 5 | 1 | 16 | 1.00 | 0.01 |
| Apr-22 | 5 | 28 | 11 | 45 | 0.45 | 0.04 |
| May-22 | 17 | 97 | 23 | 212 | 0.24 | 0.15 |
| Jun-22 | 225 | 1,289 | 487 | 2,212 | 0.07 | 2.00 |
| Jul-22 | 44 | 253 | 127 | 403 | 0.15 | 0.39 |
| Aug-22 | 11 | 63 | 34 | 97 | 0.30 | 0.1 |
| Sep-22 | 85 | 491 | 317 | 646 | 0.11 | 0.76 |
| Oct-22 | 18 | 105 | 29 | 210 | 0.24 | 0.16 |
| Nov-22 | 1 | 6 | 1 | 17 | 1.00 | 0.01 |
| Dec-22 | 3 | 18 | 3 | 35 | 0.58 | 0.03 |
| Jan-23 | 2 | 12 | 2 | 29 | 0.71 | 0.02 |
| Feb-23 | 6 | 34 | 11 | 63 | 0.41 | 0.05 |
| Mar-23 | 1 | 6 | 1 | 17 | 1.00 | 0.01 |
| Apr-23 | 14 | 79 | 14 | 232 | 0.27 | 0.12 |
| c) Survey Area | | | | | | |
| May-21 | 14 | 82 | 35 | 140 | 0.27 | 0.09 |
| Jun-21 | 114 | 671 | 353 | 1,065 | 0.09 | 0.76 |
| Jul-21 | 33 | 199 | 78 | 362 | 0.17 | 0.23 |
| Aug-21 | 71 | 412 | 267 | 557 | 0.12 | 0.47 |
| Sep-21 | 99 | 579 | 398 | 784 | 0.10 | 0.66 |
| Oct-21 | 125 | 732 | 486 | 977 | 0.09 | 0.83 |
| Nov-21 | 16 | 93 | 41 | 151 | 0.25 | 0.11 |
| Dec-21 | 4 | 23 | 4 | 52 | 0.50 | 0.03 |
| Jan-22 | 2 | 12 | 2 | 29 | 0.71 | 0.01 |
| Feb-22 | 5 | 27 | 5 | 71 | 0.45 | 0.03 |
| Mar-22 | 1 | 5 | 1 | 16 | 1.00 | 0.01 |
| Apr-22 | 12 | 69 | 17 | 156 | 0.29 | 0.08 |
| May-22 | 21 | 122 | 41 | 238 | 0.22 | 0.14 |
| Jun-22 | 258 | 1,493 | 666 | 2,448 | 0.06 | 1.69 |
| Jul-22 | 72 | 421 | 210 | 660 | 0.12 | 0.48 |
| Aug-22 | 11 | 63 | 29 | 103 | 0.30 | 0.07 |
| Sep-22 | 104 | 607 | 379 | 829 | 0.10 | 0.69 |
| Oct-22 | 47 | 276 | 76 | 600 | 0.15 | 0.31 |
| Nov-22 | 2 | 12 | 2 | 29 | 0.71 | 0.01 |
| Dec-22 | 4 | 24 | 4 | 53 | 0.50 | 0.03 |
| Jan-23 | 3 | 18 | 3 | 35 | 0.58 | 0.02 |
| Feb-23 | 8 | 46 | 17 | 75 | 0.35 | 0.05 |
| Mar-23 | 1 | 6 | 1 | 18 | 1.00 | 0.01 |
| Apr-23 | 15 | 86 | 15 | 235 | 0.26 | 0.1 |

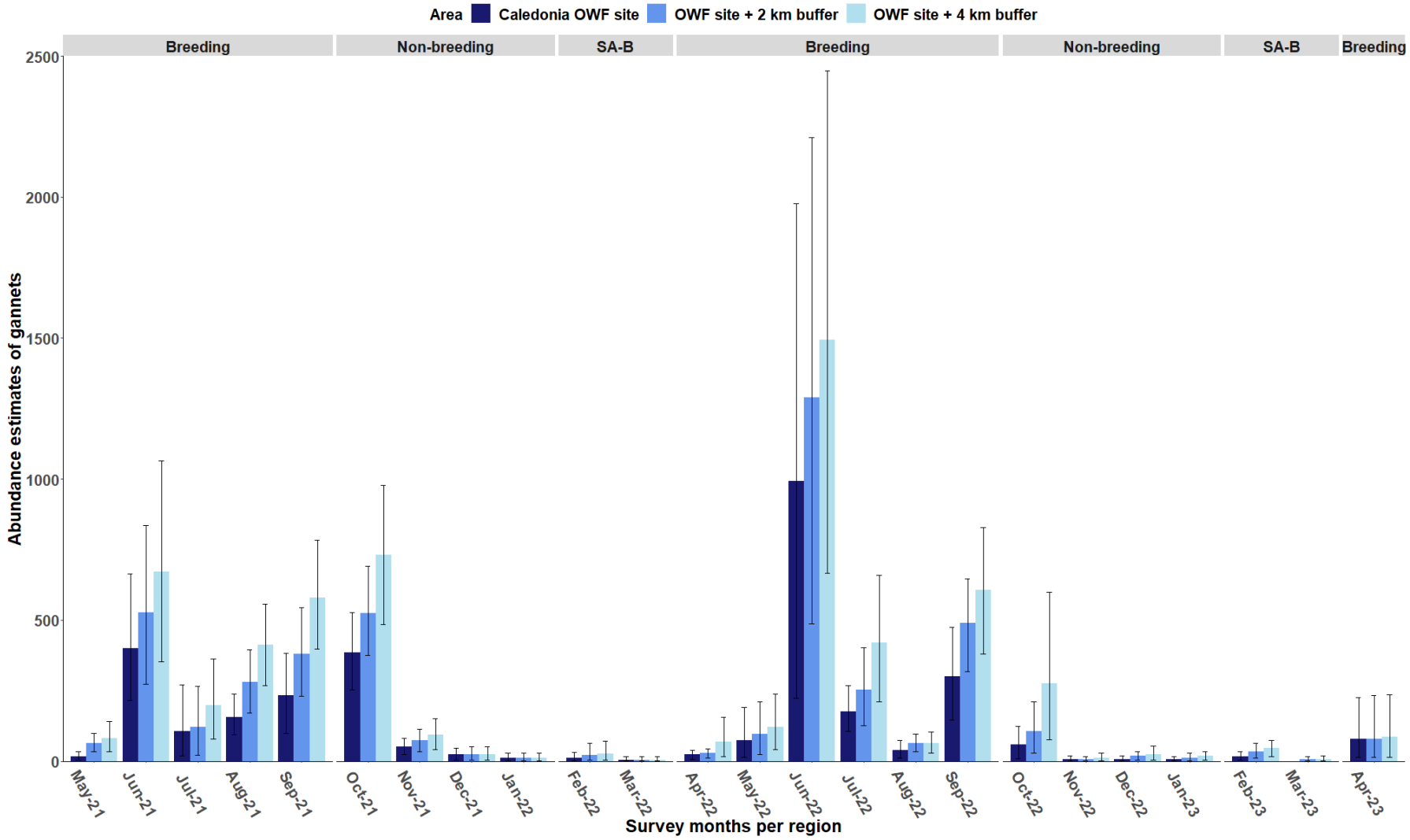



**Figure 38 Bar plot of the monthly abundance estimates (with 95% confidence intervals) of total gannets recorded in each reporting region of the Survey Area, during the May 2021 to April 2023 survey period. Gannet seasonal periods are also displayed. SA stands for breeding site attendance and SA-B corresponds to month split between SA and breeding (B)**

### *Caledonia North*

A total of 435 gannets were recorded in Caledonia North Survey Area during both years of baseline surveys (Table 9). Gannets were recorded throughout the year, except January to March 2022, November 2022, and March 2023 (Table 111, Figure 39). Within Caledonia North, Caledonia North plus 2 km buffer, and Caledonia North Survey Area, they were recorded in 16, 18 and 19 of the 24 baseline surveys respectively. Gannets were the most abundant during the non-breeding season (October to mid-March) across Caledonia North Survey Area, except in Caledonia North, where they were the most abundant during the breeding season (mid-March to September) (Table 111, Figure 39).

During the non-breeding season, peak abundance was recorded in October 2021 (Table 111, Figure 39):

- 37 individuals were recorded in Caledonia North, resulting in an unapportioned mean abundance estimates of 216 [99; 333] individuals, which equated to a mean density estimate of 0.99 birds/km$^2$.
- 61 individuals were recorded in Caledonia North plus 2 km buffer, resulting in an unapportioned mean abundance estimate of 349 [206; 497] individuals, which equated to a mean density estimate of 0.93 birds/km$^2$.
- 89 individuals were recorded in Caledonia North Survey Area, resulting in an unapportioned mean abundance estimate of 520 [316; 754] individuals, which equated to a mean density estimate of 0.93 birds/km$^2$.

In both non-breeding seasons covered by the baseline survey period, the only month where substantial numbers of gannets were recorded in Caledonia North Survey Area was October. It is considered a reasonable assumption, based on the timing of this peak, and its relative size compared with unapportioned mean abundances in other non-breeding season surveys, that these peak mean unapportioned abundances represent post-breeding aggregations of birds (likely from multiple breeding colonies across the region). Low abundances of birds were recorded in all reporting regions for the remainder of the non-breeding season surveys. It is noteworthy that the October 2021 peak was considerably larger than the October 2022 peak.

Reductions in mean apportioned and availability bias-corrected abundance relative to the peak were between 84% to 99%, with many of the surveys recording reductions in mean abundances at the upper end of this range when compared with the peak month. This reflects the fact that the October 2021 peak (which was the overall peak mean unapportioned abundance for gannet in the non-breeding season across the baseline survey period) was very large relative to the other mean unapportioned abundances recorded for gannet during the non-breeding season in Caledonia North Survey Area and reporting regions.

During the breeding season (mid-March to September), gannet peak abundances were recorded in June 2021 in Caledonia North and Caledonia North plus 2 km buffer, and June 2022 in Caledonia North Survey Area (Table 111, Figure 39):

- 42 individuals were recorded in Caledonia North in June 2021, resulting in an unapportioned mean abundance estimate of 248 [89; 497] individuals, which equated to a mean density estimate of 1.14 birds/km$^2$.
- 47 individuals were recorded in Caledonia North plus 2 km buffer in June 2021, resulting in an unapportioned mean abundance estimate of 272 [81; 521] individuals, which equated to a mean density estimate of 0.72 birds/km$^2$.
- 74 individuals were recorded in Caledonia North Survey Area in June 2022, resulting in an unapportioned mean abundance estimate of 428 [260; 630] individuals, which equated to a mean density estimate of 0.77 birds/km$^2$.

The two breeding seasons covered by the baseline survey period displayed some similarities in temporal variation in mean unapportioned gannet abundance within Caledonia North Survey Area. Abundances were relatively low in the early breeding season months (April and May), with peak mean unapportioned gannet abundance occurring in June for both breeding seasons. The following two months (July and August) recorded lower mean unapportioned gannet abundances, though higher than the early breeding season. In 2021, the August mean unapportioned gannet abundances were higher than July, and vice versa in 2022. Both September 2021 and September 2022 saw increases in mean unapportioned gannet abundance compared with previous months. The timing of this increased mean unapportioned abundance peak, and its continuation into the early part of the non-breeding season (in the 2021 breeding season in particular), suggests that Caledonia North Survey Area may be a location used by post-breeding aggregations of this species, before birds leave the wider area for the non-breeding season.

Reductions in mean unapportioned abundance relative to the peak were between 14% to 99%, with many of the surveys recording reductions in mean abundances at the upper end of this range when compared with the peak month. This indicates that the mean apportioned abundances were highly variable throughout the breeding season surveys when compared with the peak mean apportioned abundance for this season during the baseline survey period.

CV values were high, which is likely related to the relatively low numbers of individuals recorded in each region (CV > 0.16; Table 111). CV values were generally lowest during the middle part of the breeding season, and the late breeding season and autumn dispersal periods (Table 111). CV values were > 0.16 for the most part, with two of 16, three of 18, and five of 19 surveys in Caledonia North, Caledonia North plus 2 km buffer, and Caledonia North Survey Area respectively falling below this value (Table 111). This indicates lower precision for the abundance and densities calculated for this species compared to some of the more numerous species recorded during the baseline surveys. This is reflected by the relatively large 95% confidence intervals around the mean abundance estimates for this species (Table 111).

**Table 111 Raw counts, unapportioned abundance and density estimates (birds per km$^2$) of gannets in Caledonia North, Caledonia North plus 2 km buffer and Caledonia North Survey Area during the May 2021 to April 2023 survey period. Colour gradients follow the ascending order of gannet raw counts per season, with light yellow to orange (peak number) for the breeding season months (mid-March to September) and light blue to royal blue (peak number) for the wintering months (October to mid-February). No colours were attributed to the breeding site attendance period (mid-February - mid-March)**

| Survey | Raw count | Total unapportioned | | | | |
|---|---|---|---|---|---|---|
| | | Abundance | LCL | UCL | Precision (CV) | Density (km$^2$) |
| a) Caledonia North | | | | | | |
| May-21 | 1 | 6 | 1 | 17 | 1.00 | 0.03 |
| Jun-21 | 42 | 248 | 89 | 497 | 0.15 | 1.14 |
| Jul-21 | 3 | 18 | 3 | 53 | 0.58 | 0.08 |
| Aug-21 | 12 | 70 | 29 | 116 | 0.29 | 0.32 |
| Sep-21 | 25 | 145 | 35 | 267 | 0.20 | 0.66 |
| Oct-21 | 37 | 216 | 99 | 333 | 0.16 | 0.99 |
| Nov-21 | 4 | 23 | 6 | 47 | 0.50 | 0.11 |
| Dec-21 | 2 | 12 | 2 | 23 | 0.71 | 0.05 |
| Apr-22 | 3 | 17 | 6 | 34 | 0.58 | 0.08 |
| May-22 | 1 | 6 | 1 | 17 | 1.00 | 0.03 |
| Jun-22 | 21 | 120 | 74 | 171 | 0.22 | 0.55 |
| Jul-22 | 5 | 29 | 6 | 59 | 0.45 | 0.13 |
| Aug-22 | 2 | 12 | 2 | 23 | 0.71 | 0.05 |
| Sep-22 | 12 | 69 | 23 | 138 | 0.29 | 0.32 |

| Survey | Raw count | Total unapportioned | | | | |
|---|---|---|---|---|---|---|
| | | Abundance | LCL | UCL | Precision (CV) | Density (km$^2$) |
| Oct-22 | 6 | 35 | 6 | 93 | 0.41 | 0.16 |
| Feb-23 | 2 | 12 | 2 | 29 | 0.71 | 0.05 |
| b) Caledonia North plus 2 km buffer | | | | | | |
| May-21 | 7 | 40 | 11 | 74 | 0.38 | 0.11 |
| Jun-21 | 47 | 272 | 81 | 521 | 0.15 | 0.72 |
| Jul-21 | 5 | 29 | 6 | 63 | 0.45 | 0.08 |
| Aug-21 | 20 | 113 | 34 | 204 | 0.22 | 0.30 |
| Sep-21 | 41 | 233 | 97 | 398 | 0.16 | 0.62 |
| Oct-21 | 61 | 349 | 206 | 497 | 0.13 | 0.93 |
| Nov-21 | 5 | 29 | 6 | 57 | 0.45 | 0.08 |
| Dec-21 | 2 | 11 | 2 | 28 | 0.71 | 0.03 |
| Apr-22 | 3 | 17 | 3 | 34 | 0.58 | 0.05 |
| May-22 | 4 | 23 | 4 | 46 | 0.50 | 0.06 |
| Jun-22 | 36 | 208 | 121 | 294 | 0.17 | 0.55 |
| Jul-22 | 13 | 74 | 34 | 120 | 0.28 | 0.20 |
| Aug-22 | 6 | 34 | 6 | 69 | 0.41 | 0.09 |
| Sep-22 | 28 | 163 | 99 | 227 | 0.19 | 0.43 |
| Oct-22 | 7 | 41 | 7 | 100 | 0.38 | 0.11 |
| Dec-22 | 1 | 6 | 1 | 18 | 1.00 | 0.02 |
| Jan-23 | 1 | 6 | 1 | 18 | 1.00 | 0.02 |
| Feb-23 | 5 | 29 | 6 | 51 | 0.45 | 0.08 |
| c) Caledonia North Survey Area | | | | | | |
| May-21 | 8 | 47 | 12 | 82 | 0.35 | 0.08 |
| Jun-21 | 51 | 302 | 101 | 586 | 0.14 | 0.54 |
| Jul-21 | 9 | 55 | 18 | 97 | 0.33 | 0.10 |
| Aug-21 | 26 | 151 | 70 | 255 | 0.20 | 0.27 |
| Sep-21 | 60 | 350 | 187 | 532 | 0.13 | 0.63 |
| Oct-21 | 89 | 520 | 316 | 754 | 0.11 | 0.93 |
| Nov-21 | 6 | 35 | 6 | 70 | 0.41 | 0.06 |
| Dec-21 | 2 | 12 | 2 | 29 | 0.71 | 0.02 |
| Apr-22 | 4 | 23 | 6 | 40 | 0.50 | 0.04 |
| May-22 | 7 | 41 | 12 | 81 | 0.38 | 0.07 |
| Jun-22 | 74 | 428 | 260 | 630 | 0.12 | 0.77 |
| Jul-22 | 25 | 146 | 59 | 263 | 0.20 | 0.26 |
| Aug-22 | 7 | 40 | 11 | 74 | 0.38 | 0.07 |
| Sep-22 | 46 | 268 | 151 | 402 | 0.15 | 0.48 |
| Oct-22 | 10 | 59 | 18 | 123 | 0.32 | 0.11 |
| Dec-22 | 3 | 18 | 3 | 35 | 0.58 | 0.03 |
| Jan-23 | 1 | 6 | 1 | 18 | 1.00 | 0.01 |
| Feb-23 | 6 | 35 | 12 | 64 | 0.41 | 0.06 |
| Apr-23 | 1 | 6 | 1 | 17 | 1.00 | 0.01 |

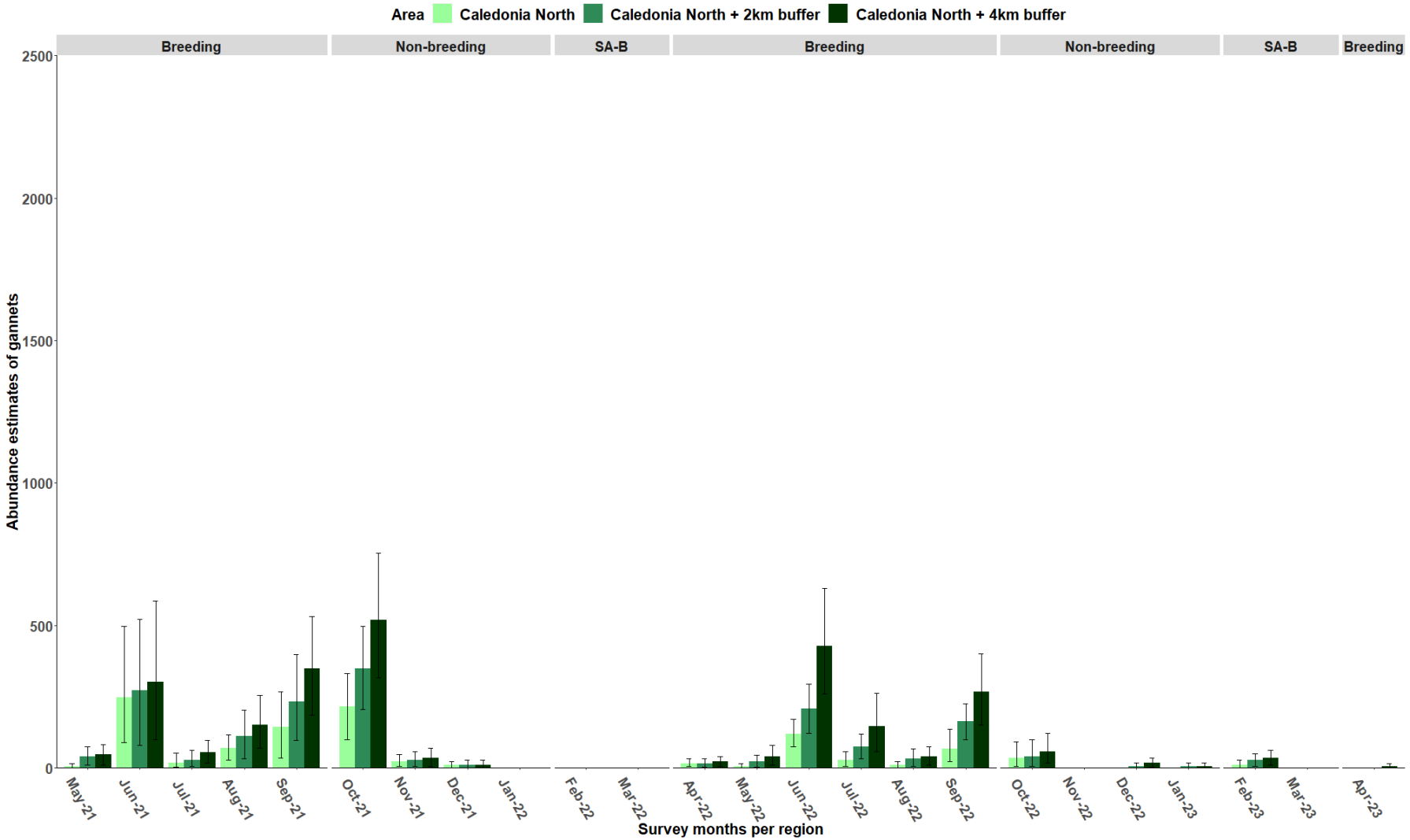



**Figure 39 Bar plot of the monthly abundance estimates (with 95% confidence intervals) of total gannets recorded in each reporting region of Caledonia North Survey Area, during the May 2021 to April 2023 survey period. Gannet seasonal periods are also displayed. SA stands for breeding site attendance and SA-B corresponds to month split between SA and breeding (B)**

### *Caledonia South*

A total of 807 gannets were recorded in Caledonia South Survey Area during both years of baseline surveys (Table 10). Gannets were recorded throughout the year, being recorded in Caledonia South in 23 of 24 baseline surveys, and Caledonia South plus buffers in every survey (Table 112, Figure 40). Gannets were the most abundant during the breeding season (mid-March to September). Peak of abundance was recorded in June 2022 (Table 112, Figure 40):

- 152 individuals were recorded in Caledonia South, resulting in an unapportioned mean abundance estimate of 880 [185; 1,807] individuals, which equated to a mean density estimate of 4.18 birds/km$^2$.
- 196 individuals were recorded in Caledonia South plus 2 km buffer, resulting in an unapportioned mean abundance estimate of 1,113 [324; 2,066] individuals, which equated to a mean density estimate of 3.10 birds/km$^2$.
- 222 individuals were recorded in Caledonia South Survey Area, resulting in an unapportioned mean abundance estimate of 1,286 [492; 2,253] individuals, which equated to a mean density estimate of 2.41 birds/km$^2$.

The two breeding seasons covered by the baseline survey period displayed some similarities in temporal variation in mean unapportioned gannet abundance. Abundances were relatively low in the early breeding season months (April and May), with peak mean unapportioned gannet abundance occurring in June for both breeding seasons. The most striking difference between unapportioned mean abundances in the 2021 and 2022 breeding seasons is the size of the peak in June, with the 2022 peak being very large relative to other months around it (as well as other months in the 2021 breeding season). The peak abundance of gannets during the breeding season (June 2022) was considerably higher than other months, with over twice the number of birds recorded in Caledonia South reporting regions when compared with the next most abundant month across the baseline survey period.

The following two months of each breeding season (July and August) recorded lower mean unapportioned gannet abundances than June. In 2021, the August mean unapportioned gannet abundances were higher than July, and vice versa in 2022 (when mean unapportioned abundances were particularly low). Abundances remained at a similar level in September 2021 compared with the previous month, and actually increased substantially between August 2021 and September 2022. This, coupled with the continued use of the area into October in both years, suggests that Caledonia South Survey Area may be a location used by post-breeding aggregations of this species.

During the non-breeding season (October to mid-March), gannets were particularly abundant in October 2021, which is when the peak was recorded (Table 112, Figure 40):

- 29 individuals were recorded in Caledonia South, resulting in an unapportioned mean abundance estimate of 170 [105; 228] individuals, which equated to a mean density estimate of 0.81 birds/km$^2$.
- 46 individuals were recorded in Caledonia South plus 2 km buffer, resulting in an unapportioned mean abundance estimate of 267 [186; 354] individuals, which equated to a mean density estimate of 0.74 birds/km$^2$.
- 82 individuals were recorded in Caledonia South Survey Area, resulting in an unapportioned mean abundance estimate of 476 [366; 598] individuals, which equated to a mean density estimate of 0.89 birds/km$^2$.

In both non-breeding seasons covered by the baseline survey period, the only month where substantial numbers of gannets were recorded in Caledonia South Survey Area was October. It is considered a reasonable assumption, based on the timing of this peak, and its relative size compared with unapportioned mean abundances in other non-breeding season surveys, that these peak mean unapportioned abundances represent post-breeding aggregations of birds (likely from multiple

breeding colonies across the region). Low abundances of birds were recorded in all reporting regions for the remainder of the non-breeding season surveys. It is noteworthy that the October 2021 peak was considerably larger than the October 2022 peak.

Reductions in mean apportioned and availability bias-corrected abundance relative to the peak were between 63% to 98%, with many of the surveys recording reductions in mean abundances at the upper end of this range when compared with the peak month. This reflects the fact that the October 2021 peak (which was the overall peak mean unapportioned abundance for gannet in the non-breeding season across the baseline survey period) was very large relative to the other mean unapportioned abundances recorded for gannet during the non-breeding season in Caledonia South Survey Area and reporting regions.

Relatively good measures of precisions (CV ≤ 0.16) were calculated for survey month where raw counts of individuals where higher, and measures of precisions were high when raw counts of individual were low (CV > 0.16; Table 112). CV values were generally lowest during the middle part of the breeding season, and the late breeding season and autumn dispersal periods (Table 112). CV values were > 0.16 for the most part, with two of 23, six of 24, and eight of 24 surveys in Caledonia South, Caledonia South plus 2 km buffer, and Caledonia South Survey Area respectively falling below this value (Table 112). This indicates lower precision for the abundance and densities calculated for this species compared to some of the more numerous species recorded during the baseline surveys. This is reflected by the relatively large 95% confidence intervals around the mean abundance estimates for this species (Table 112).

**Table 112 Raw counts, unapportioned abundance and density estimates (birds per km$^2$) of gannets in Caledonia South, Caledonia South plus 2 km buffer and Caledonia South Survey Area during the May 2021 to April 2023 survey period. Colour gradients follow the ascending order of gannet raw counts per season, with light yellow to orange (peak number) for the breeding season months (mid-March to September) and light blue to royal blue (peak number) for the wintering months (October to mid-February). No colours were attributed to the breeding site attendance period (mid-February - mid-March)**

| Survey | Raw count | Total unapportioned | | | | |
|---|---|---|---|---|---|---|
| | | Abundance | LCL | UCL | Precision (CV) | Density (km$^2$) |
| a) Caledonia South | | | | | | |
| May-21 | 2 | 12 | 2 | 29 | 0.71 | 0.06 |
| Jun-21 | 26 | 151 | 81 | 262 | 0.20 | 0.72 |
| Jul-21 | 15 | 88 | 15 | 229 | 0.26 | 0.42 |
| Aug-21 | 15 | 87 | 46 | 144 | 0.26 | 0.41 |
| Sep-21 | 15 | 87 | 23 | 162 | 0.26 | 0.41 |
| Oct-21 | 29 | 170 | 105 | 228 | 0.19 | 0.81 |
| Nov-21 | 5 | 29 | 6 | 52 | 0.45 | 0.14 |
| Dec-21 | 2 | 12 | 2 | 35 | 0.71 | 0.06 |
| Jan-22 | 2 | 12 | 2 | 29 | 0.71 | 0.06 |
| Feb-22 | 2 | 11 | 2 | 32 | 0.71 | 0.05 |
| Mar-22 | 1 | 5 | 1 | 16 | 1.00 | 0.02 |
| Apr-22 | 1 | 6 | 1 | 17 | 1.00 | 0.03 |
| May-22 | 12 | 69 | 12 | 185 | 0.29 | 0.33 |
| Jun-22 | 152 | 880 | 185 | 1,807 | 0.08 | 4.18 |
| Jul-22 | 25 | 146 | 70 | 239 | 0.20 | 0.69 |
| Aug-22 | 5 | 29 | 6 | 52 | 0.45 | 0.14 |
| Sep-22 | 41 | 239 | 122 | 350 | 0.16 | 1.14 |
| Oct-22 | 4 | 24 | 4 | 47 | 0.50 | 0.11 |
| Nov-22 | 1 | 6 | 1 | 18 | 1.00 | 0.03 |
| Dec-22 | 1 | 6 | 1 | 18 | 1.00 | 0.03 |
| Jan-23 | 1 | 6 | 1 | 18 | 1.00 | 0.03 |

| Survey | Raw count | Total unapportioned | | | | |
|---|---|---|---|---|---|---|
| | | Abundance | LCL | UCL | Precision (CV) | Density (km$^2$) |
| Feb-23 | 1 | 6 | 1 | 17 | 1.00 | 0.03 |
| Apr-23 | 14 | 80 | 14 | 228 | 0.27 | 0.38 |
| b) Caledonia South plus 2 km buffer | | | | | | |
| May-21 | 5 | 29 | 6 | 52 | 0.45 | 0.08 |
| Jun-21 | 52 | 302 | 157 | 487 | 0.14 | 0.84 |
| Jul-21 | 16 | 93 | 16 | 233 | 0.25 | 0.26 |
| Aug-21 | 37 | 212 | 155 | 275 | 0.16 | 0.59 |
| Sep-21 | 26 | 150 | 87 | 231 | 0.20 | 0.42 |
| Oct-21 | 46 | 267 | 186 | 354 | 0.15 | 0.74 |
| Nov-21 | 9 | 52 | 17 | 92 | 0.33 | 0.14 |
| Dec-21 | 2 | 12 | 2 | 35 | 0.71 | 0.03 |
| Jan-22 | 2 | 11 | 2 | 29 | 0.71 | 0.03 |
| Feb-22 | 4 | 21 | 4 | 64 | 0.50 | 0.06 |
| Mar-22 | 1 | 5 | 1 | 16 | 1.00 | 0.01 |
| Apr-22 | 3 | 17 | 6 | 34 | 0.58 | 0.05 |
| May-22 | 13 | 75 | 13 | 189 | 0.28 | 0.21 |
| Jun-22 | 196 | 1,113 | 324 | 2,066 | 0.07 | 3.10 |
| Jul-22 | 38 | 220 | 87 | 382 | 0.16 | 0.61 |
| Aug-22 | 9 | 51 | 29 | 74 | 0.33 | 0.14 |
| Sep-22 | 68 | 388 | 234 | 548 | 0.12 | 1.08 |
| Oct-22 | 17 | 98 | 23 | 225 | 0.24 | 0.27 |
| Nov-22 | 1 | 6 | 1 | 17 | 1.00 | 0.02 |
| Dec-22 | 2 | 12 | 2 | 29 | 0.71 | 0.03 |
| Jan-23 | 2 | 11 | 2 | 29 | 0.71 | 0.03 |
| Feb-23 | 2 | 11 | 2 | 29 | 0.71 | 0.03 |
| Mar-23 | 1 | 6 | 1 | 17 | 1.00 | 0.02 |
| Apr-23 | 14 | 78 | 14 | 230 | 0.27 | 0.22 |
| c) Caledonia South Survey Area | | | | | | |
| May-21 | 8 | 46 | 17 | 75 | 0.35 | 0.09 |
| Jun-21 | 79 | 459 | 250 | 750 | 0.11 | 0.86 |
| Jul-21 | 28 | 168 | 54 | 336 | 0.19 | 0.31 |
| Aug-21 | 57 | 328 | 224 | 443 | 0.13 | 0.61 |
| Sep-21 | 47 | 273 | 145 | 436 | 0.15 | 0.51 |
| Oct-21 | 82 | 476 | 366 | 598 | 0.11 | 0.89 |
| Nov-21 | 14 | 80 | 29 | 138 | 0.27 | 0.15 |
| Dec-21 | 2 | 12 | 2 | 35 | 0.71 | 0.02 |
| Jan-22 | 2 | 12 | 2 | 29 | 0.71 | 0.02 |
| Feb-22 | 5 | 27 | 5 | 71 | 0.45 | 0.05 |
| Mar-22 | 1 | 5 | 1 | 16 | 1.00 | 0.01 |
| Apr-22 | 10 | 57 | 10 | 138 | 0.32 | 0.11 |
| May-22 | 16 | 92 | 23 | 213 | 0.25 | 0.17 |
| Jun-22 | 222 | 1,286 | 492 | 2,253 | 0.07 | 2.41 |
| Jul-22 | 69 | 399 | 162 | 654 | 0.12 | 0.75 |
| Aug-22 | 9 | 52 | 23 | 80 | 0.33 | 0.10 |
| Sep-22 | 86 | 502 | 274 | 718 | 0.11 | 0.94 |
| Oct-22 | 42 | 247 | 65 | 564 | 0.15 | 0.46 |
| Nov-22 | 2 | 12 | 2 | 29 | 0.71 | 0.02 |
| Dec-22 | 3 | 18 | 3 | 41 | 0.58 | 0.03 |
| Jan-23 | 3 | 18 | 3 | 35 | 0.58 | 0.03 |
| Feb-23 | 3 | 17 | 3 | 35 | 0.58 | 0.03 |
| Mar-23 | 1 | 6 | 1 | 17 | 1.00 | 0.01 |
| Apr-23 | 16 | 92 | 16 | 246 | 0.25 | 0.17 |

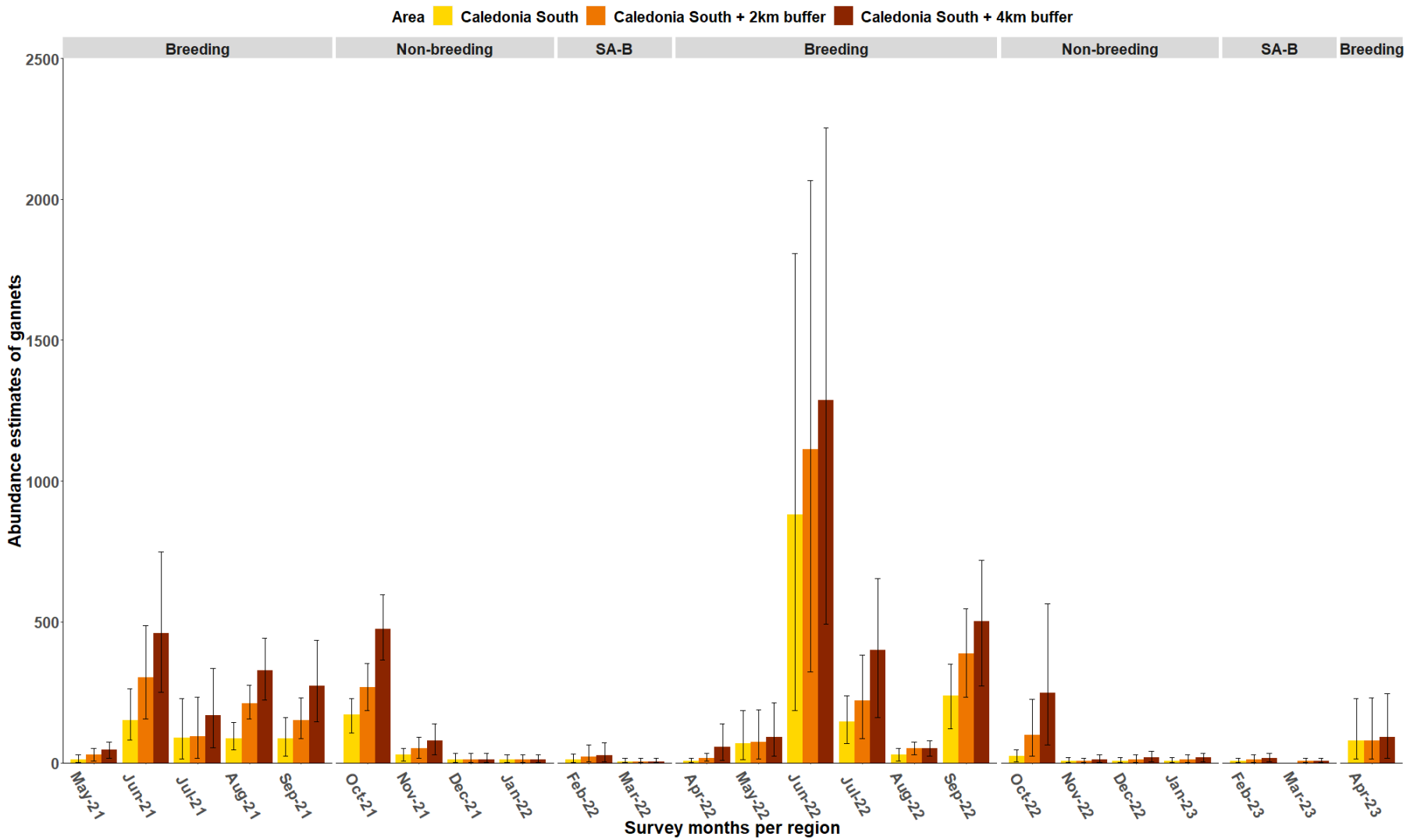



**Figure 40 Bar plot of the monthly abundance estimates (with 95% confidence intervals) of total gannets recorded in each reporting region of Caledonia South Survey Area, during the May 2021 to April 2023 survey period. Gannet seasonal periods are also displayed. SA stands for breeding site attendance and SA-B corresponds to month split between SA and breeding (B)**

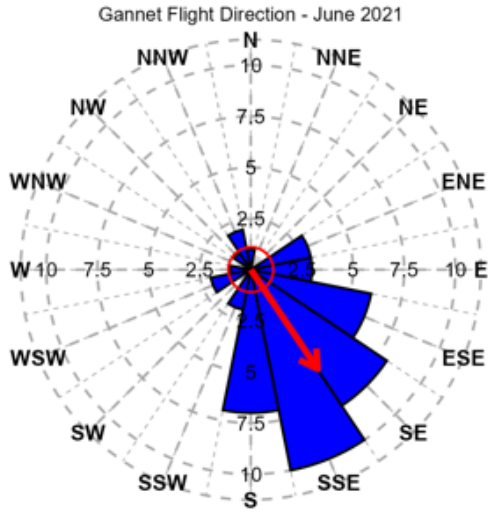
### *ii. Distribution and behaviour*

Distribution maps are shown in Appendix 4: Figure A4.264-287. Overall, gannets were recorded throughout the Survey Area. In July and August 2021, they were mostly in the south of the Survey Area (Figure A4.266-267), while most individuals in September 2021 were in the northwest and the south (Figure A4.268). Between January and March 2022, a small number of gannets were recorded in Caledonia South and its Buffer Zone (Figures A4.272-274). In June 2002, the highest numbers of gannets were recorded in the western half of the Survey Area (Figure A4.277). Between July 2022 and January 2023, gannets occurred throughout the Survey Area, although the highest numbers were seen in Caledonia South (Figures A4.278-284). In other months, they were more loosely distributed across the Survey Area (Figures A4. 264-264, 269-271, 275-26, 285-287). Distribution during the breeding season appeared more skewed towards the southern half of the Survey Area, indicating that birds could have originated from the Troup, Pennan and Lion's Heads SPA, which supports a breeding colony of gannets (though the species is not a qualifying feature of the SPA).

Significant predominant direction of flight was recorded in:

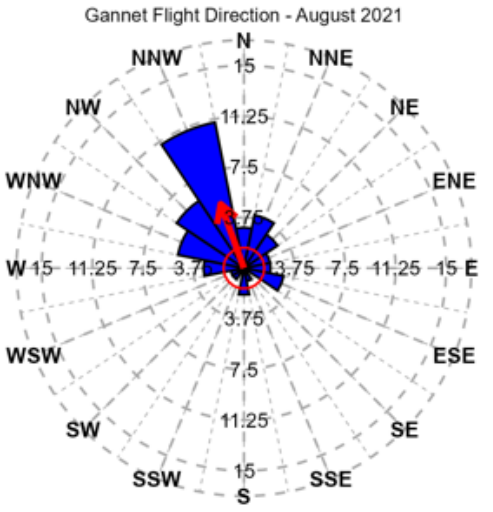
- **June**
  - 2021 southeast (Figure 41a)
  - 2022 east-northeast (Figure 41e)
- **July**
  - 2022 east-southeast (Figure 41f)
- **August**
  - 2021 north-northwest (Figure 41b)
- **September**
  - 2022 southeast (Figure 41g)
- **October**
  - 2021 southeast (Figure 41c)
  - 2022 south-southwest (Figure 41h)
- **November**
  - 2021 east-southeast (Figure 41d)
- **February**
  - 2023 east (Figure 41i)

As very few birds were recorded in flight in other surveys, they were too infrequent to determine any preference in flight direction (Appendix 5, Figure A5.23).



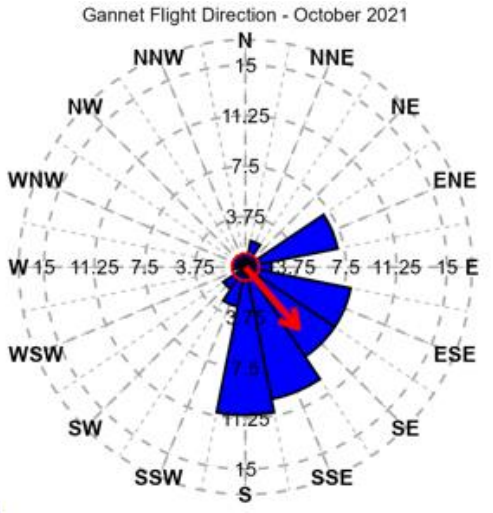

| | |
|---|---|
| Number of Observations | 46 |
| Mean Vector (μ) | 146.023 |
| Length of Mean Vector (r) | 0.585 |
| Rayleigh Test (Z) | 15.733 |
| Rayleigh Test (p) | <0.001 |

**a June 2021**



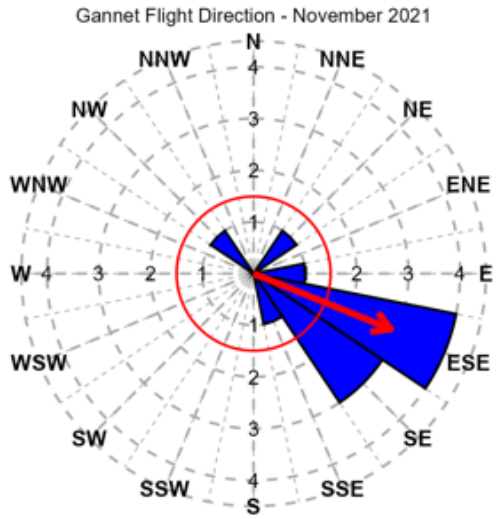

| | |
|---|---|
| Number of Observations | 47 |
| Mean Vector (μ) | 340.832 |
| Length of Mean Vector (r) | 0.459 |
| Rayleigh Test (Z) | 9.892 |
| Rayleigh Test (p) | <0.001 |

**b August 2021**



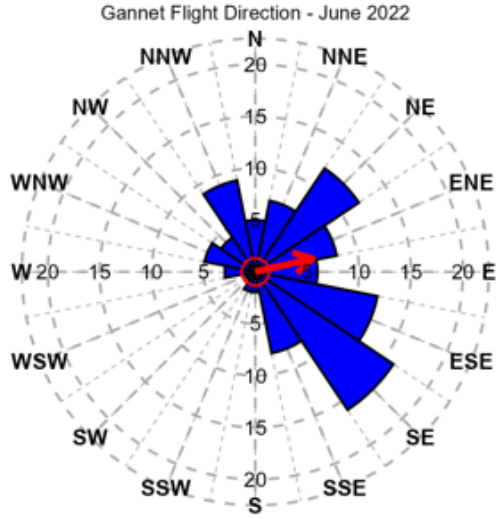

| | |
|---|---|
| Number of Observations | 59 |
| Mean Vector (μ) | 139.938 |
| Length of Mean Vector (r) | 0.541 |
| Rayleigh Test (Z) | 17.261 |
| Rayleigh Test (p) | <0.001 |

**c October 2021**



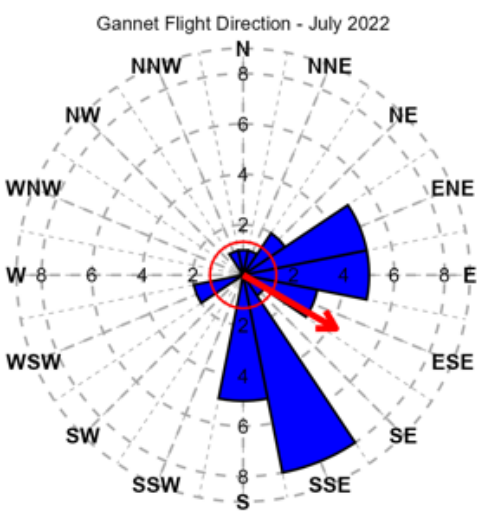

| | |
|---|---|
| Number of Observations | 11 |
| Mean Vector (μ) | 112.987 |
| Length of Mean Vector (r) | 0.717 |
| Rayleigh Test (Z) | 5.648 |
| Rayleigh Test (p) | 0.002 |

**d November 2021**



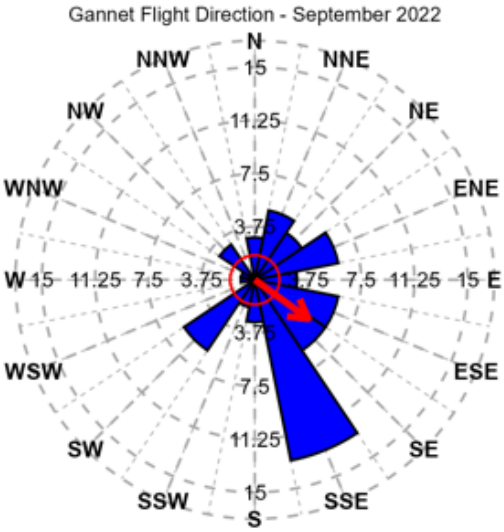

| | |
|---|---|
| Number of Observations | 101 |
| Mean Vector (μ) | 77.505 |
| Length of Mean Vector (r) | 0.353 |
| Rayleigh Test (Z) | 12.553 |
| Rayleigh Test (p) | <0.001 |

**e June 2022**



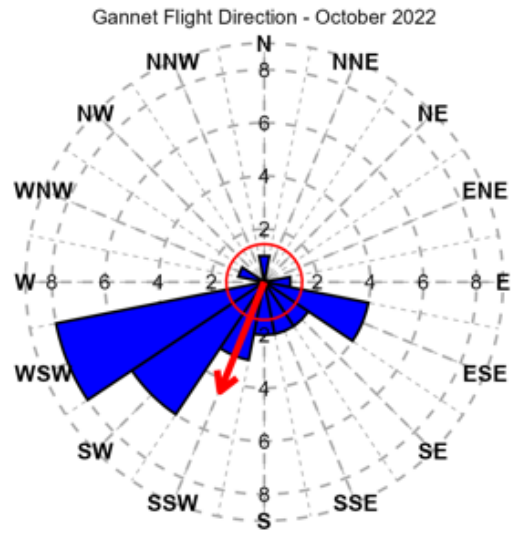

| | |
|---|---|
| Number of Observations | 34 |
| Mean Vector (μ) | 120.057 |
| Length of Mean Vector (r) | 0.531 |
| Rayleigh Test (Z) | 9.575 |
| Rayleigh Test (p) | <0.001 |

**f July 2022**



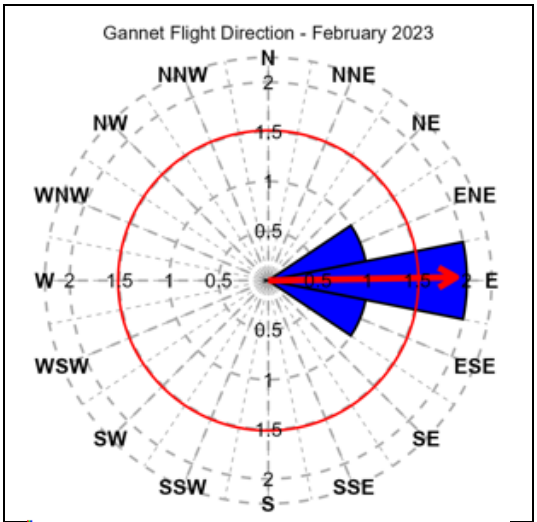

| | |
|---|---|
| Number of Observations | 62 |
| Mean Vector (μ) | 126.594 |
| Length of Mean Vector (r) | 0.358 |
| Rayleigh Test (Z) | 7.947 |
| Rayleigh Test (p) | <0.001 |

**g September 2022**




| | |
|---|---|
| Number of Observations | 30 |
| Mean Vector (μ) | 202.354 |
| Length of Mean Vector (r) | 0.555 |
| Rayleigh Test (Z) | 9.250 |
| Rayleigh Test (p) | <0.001 |

**h October 2022**




| | |
|---|---|
| Number of Observations | 4 |
| Mean Vector (μ) | 89.122 |
| Length of Mean Vector (r) | 0.945 |
| Rayleigh Test (Z) | 3.574 |
| Rayleigh Test (p) | 0.016 |
| **i February 2023** | |

**Figure 41 Summary of flight direction of gannets within surveys where a significant flight direction was recorded during the May 2021 to April 2023 survey period**

### 4.34 Unidentified thrush species

#### *i. Abundance and density estimates*

A total of 289 unidentified thrushes were recorded in the Survey Area in October 2022 (Table 8, Table 113). This resulted in an unapportioned mean abundance estimate of 1,699 [382; 3,321] individuals, which equated in a mean density estimate of 1.92 birds/km$^2$ (Table 113). It is reasonable to assume, given the timing of the records and the group to which these records were assigned, that these were birds on migration.

**Table 113 Raw counts, unapportioned abundance and density estimates (birds per km$^2$) of unidentified thrush species in Caledonia OWF, Caledonia OWF plus 2 km buffer and the Survey Area during the May 2021 to April 2023 survey period**

| Survey | Raw count | Total unapportioned | | | | |
|---|---|---|---|---|---|---|
| | | Abundance | LCL | UCL | Precision (CV) | Density (km$^2$) |
| **a) Caledonia OWF** | | | | | | |
| **Oct-22** | 17 | 99 | 18 | 245 | 0.24 | 0.23 |
| **b) Caledonia OWF plus 2 km buffer** | | | | | | |
| **Oct-22** | 114 | 664 | 114 | 1,736 | 0.09 | 1.03 |
| **c) Survey Area** | | | | | | |
| **Oct-22** | 289 | 1,699 | 382 | 3,321 | 0.06 | 1.92 |

In Caledonia North Survey Area, a total of 214 unidentified thrushes were recorded in October 2022 (Table 9). This resulted in an unapportioned mean abundance estimate of 1,257 [317; 2,460] individuals, which equated to a mean density estimate of 2.26 birds/km$^2$ (

Table 114).

**Table 114 Raw counts, unapportioned abundance and density estimates (birds per km$^2$) of unidentified thrush species in Caledonia North, Caledonia North plus 2 km buffer and Caledonia North Survey Area during the May 2021 to April 2023 survey period**

| Survey | Raw count | Total unapportioned | | | | |
|---|---|---|---|---|---|---|
| | | Abundance | LCL | UCL | Precision (CV) | Density (km$^2$) |
| **a) Caledonia North** | | | | | | |
| **Oct-22** | 4 | 23 | 4 | 58 | 0.50 | 0.11 |
| **b) Caledonia North plus 2 km buffer** | | | | | | |
| **Oct-22** | 105 | 617 | 105 | 1,733 | 0.10 | 1.64 |
| **c) Caledonia North Survey Area** | | | | | | |
| **Oct-22** | 214 | 1,257 | 317 | 2,460 | 0.07 | 2.26 |

In Caledonia South Survey Area, a total of 188 unidentified thrushes were recorded in October 2022 (Table 10). This resulted in an unapportioned mean abundance estimate of 1,104 [188; 2,350] individuals, which equated to a mean density estimate of 2.07 birds/km$^2$ (Table 115).

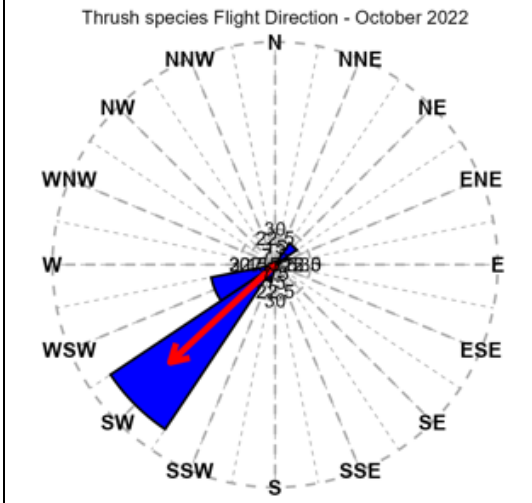
**Table 115 Raw counts, unapportioned abundance and density estimates (birds per km$^2$) of unidentified thrush species in Caledonia South, Caledonia South plus 2 km buffer and Caledonia South Survey Area during the May 2021 to April 2023 survey period**

| Survey | Raw count | Total unapportioned | | | | |
|---|---|---|---|---|---|---|
| | | Abundance | LCL | UCL | Precision (CV) | Density (km$^2$) |
| **a) Caledonia South** | | | | | | |
| **Oct-22** | 13 | 76 | 13 | 217 | 0.28 | 0.36 |
| **b) Caledonia South plus 2 km buffer** | | | | | | |
| **Oct-22** | 62 | 357 | 62 | 1,048 | 0.13 | 0.99 |
| **c) Caledonia South Survey Area** | | | | | | |
| **Oct-22** | 188 | 1,104 | 188 | 2,350 | 0.07 | 2.07 |

### *ii. Distribution and behaviour*

Unidentified thrushes were only recorded in October 2022, scattered across the Survey Area, however, with most records in Caledonia North Survey Area (Appendix 4, Figure A4.288).

All unidentified thrushes were recorded flying in a significant south-westerly direction in October 2022.




| | |
|---|---|
| Number of Observations | 289 |
| Mean Vector (μ) | 227.364 |
| Length of Mean Vector (r) | 0.724 |
| Rayleigh Test (Z) | 151.365 |
| Rayleigh Test (p) | <0.001 |
| **October 2022** | |

**Figure 42 Summary of flight direction of thrush species within surveys where a significant flight direction was recorded during the May 2021 to April 2023 survey period**

## 4.35 Unidentified passerine species

### *i. Abundance and density estimates*

A total of 78 unidentified passerines were recorded in the Survey Area in October 2022 (Table 8, Table 116). This resulted in an unapportioned mean abundance estimate of 459 [78; 894] individuals, which equated to a mean density estimate of 0.52 birds/km$^2$ (Table 116). It is reasonable to assume, given the timing of the records and the group to which these records were assigned, that these were birds on migration.

**Table 116 Raw counts, unapportioned abundance and density estimates (birds per km$^2$) of passerine species in Caledonia OWF, Caledonia OWF plus 2 km buffer and the Survey Area during the May 2021 to April 2023 survey period**

| Survey | Raw count | Total unapportioned | | | | |
|---|---|---|---|---|---|---|
| | | Abundance | LCL | UCL | Precision (CV) | Density (km$^2$) |
| **a) Caledonia OWF** | | | | | | |
| **Oct-22** | 16 | 93 | 16 | 257 | 0.25 | 0.22 |
| **b) Caledonia OWF plus 2 km buffer** | | | | | | |
| **Oct-22** | 17 | 99 | 17 | 274 | 0.24 | 0.15 |
| **c) Survey Area** | | | | | | |
| **Oct-22** | 78 | 459 | 78 | 894 | 0.11 | 0.52 |

A total of 57 unidentified passerines recorded in Caledonia North Survey Area in October 2022 (Table 9, Table 117). This resulted in an unapportioned mean abundance estimate of 335 [57; 693] individuals, which equated to a mean density estimate of 0.60 birds/km$^2$ (Table 117).

**Table 117 Raw counts, unapportioned abundance and density estimates (birds per km²) of passerine species in Caledonia North, Caledonia North plus 2 km buffer and Caledonia North Survey Area during the May 2021 to April 2023 survey period**

| Survey | Raw count | Total unapportioned | | | | |
|---|---|---|---|---|---|---|
| | | Abundance | LCL | UCL | Precision (CV) | Density (km²) |
| **a) Caledonia North** | | | | | | |
| **Oct-22** | 14 | 81 | 14 | 243 | 0.27 | 0.37 |
| **b) Caledonia North plus 2 km buffer** | | | | | | |
| **Oct-22** | 17 | 100 | 17 | 276 | 0.24 | 0.27 |
| **c) Caledonia North Survey Area** | | | | | | |
| **Oct-22** | 57 | 335 | 57 | 693 | 0.13 | 0.60 |

A total of 37 unidentified passerines were recorded in Caledonia South Survey Area in October 2022 (Table 10, Table 118). This resulted in an unapportioned mean abundance of estimate 217 [37; 441] individuals, which equated to a mean density estimate of 0.41 birds/km$^2$ (Table 118).

**Table 118 Raw counts, unapportioned abundance and density estimates (birds per km²) of passerine species in Caledonia South, Caledonia South plus 2 km buffer and Caledonia South Survey Area during the May 2021 to April 2023 survey period**

| Survey | Raw count | Total unapportioned | | | | |
|---|---|---|---|---|---|---|
| | | Abundance | LCL | UCL | Precision (CV) | Density (km²) |
| **a) Caledonia South** | | | | | | |
| **Oct-22** | 2 | 12 | 2 | 35 | 0.71 | 0.06 |
| **b) Caledonia South plus 2 km buffer** | | | | | | |
| **Oct-22** | 2 | 12 | 2 | 35 | 0.71 | 0.03 |
| **c) Caledonia South Survey Area** | | | | | | |
| **Oct-22** | 37 | 217 | 37 | 441 | 0.16 | 0.41 |

#### *ii. Distribution and behaviour*

Unidentified passerines were largely recorded in the northeast of the Survey Area, across both Caledonia North and South in October 2022 (Appendix 4, Figure A4.289).

All unidentified passerines recorded were flying with no significant preference in flight direction (Appendix 5, Figure A5.29).

### 4.36 Unidentified bird species

#### *i. Abundance and density estimates*

A total of 54 unidentified birds were recorded in the Survey Area during both years of baseline surveys (Table 8). Unidentified birds were not apportioned to species as it is a too broad group to attribute to species. Unidentified birds were recorded in every survey, except in November 2021, April 2022, January to April 2023 (Table 8). Peak numbers were recorded in July 2022, with nine individuals recorded in the Survey Area, resulting in a mean abundance estimate of 53 [23; 82] individuals, which equated to a mean density estimate of 0.06 birds/km$^2$ (Table 119). The peak mean abundance estimate in Caledonia OWF was of 23 unidentified birds in July 2022, while in Caledonia plus 2 km buffer, a peak mean abundance estimate of 46 individuals were recorded in May 2021 (Table 119).

**Table 119 Raw counts, unapportioned abundance and density estimates (birds per km²) of unidentified bird species in Caledonia OWF, Caledonia OWF plus 2 km buffer and the Survey Area during the May 2021 to April 2023 survey period**

| Survey | Raw count | Total unapportioned | | | | |
|---|---|---|---|---|---|---|
| | | Abundance | LCL | UCL | Precision (CV) | Density (km²) |
| **a) Caledonia OWF** | | | | | | |
| **May-21** | 1 | 6 | 1 | 17 | 1.00 | 0.01 |

| Survey | Raw count | Total unapportioned | | | | |
|---|---|---|---|---|---|---|
| | | Abundance | LCL | UCL | Precision (CV) | Density (km²) |
| **Jun-21** | 3 | 18 | 3 | 35 | 0.58 | 0.04 |
| **Aug-21** | 3 | 17 | 3 | 46 | 0.58 | 0.04 |
| **Sep-21** | 1 | 6 | 1 | 17 | 1.00 | 0.01 |
| **Dec-21** | 3 | 17 | 3 | 41 | 0.58 | 0.04 |
| **Jan-22** | 2 | 12 | 2 | 29 | 0.71 | 0.03 |
| **May-22** | 2 | 12 | 2 | 29 | 0.71 | 0.03 |
| **Jun-22** | 1 | 6 | 1 | 17 | 1.00 | 0.01 |
| **Jul-22** | 4 | 23 | 4 | 53 | 0.5 | 0.05 |
| **Sep-22** | 1 | 6 | 1 | 17 | 1.00 | 0.01 |
| **Nov-22** | 1 | 6 | 1 | 18 | 1.00 | 0.01 |
| **b) Caledonia OWF plus 2 km buffer** | | | | | | |
| **May-21** | 8 | 46 | 8 | 126 | 0.35 | 0.07 |
| **Jun-21** | 3 | 17 | 3 | 35 | 0.58 | 0.03 |
| **Jul-21** | 1 | 6 | 1 | 17 | 1.00 | 0.01 |
| **Aug-21** | 3 | 17 | 3 | 46 | 0.58 | 0.03 |
| **Sep-21** | 2 | 11 | 2 | 29 | 0.71 | 0.02 |
| **Oct-21** | 1 | 6 | 1 | 17 | 1.00 | 0.01 |
| **Dec-21** | 4 | 23 | 4 | 46 | 0.50 | 0.04 |
| **Jan-22** | 2 | 11 | 2 | 29 | 0.71 | 0.02 |
| **Feb-22** | 1 | 5 | 1 | 16 | 1.00 | 0.01 |
| **May-22** | 2 | 11 | 2 | 29 | 0.71 | 0.02 |
| **Jun-22** | 3 | 17 | 3 | 40 | 0.58 | 0.03 |
| **Jul-22** | 6 | 35 | 12 | 58 | 0.41 | 0.05 |
| **Aug-22** | 1 | 6 | 1 | 17 | 1.00 | 0.01 |
| **Sep-22** | 1 | 6 | 1 | 17 | 1.00 | 0.01 |
| **Nov-22** | 1 | 6 | 1 | 17 | 1.00 | 0.01 |
| **Dec-22** | 1 | 6 | 1 | 18 | 1.00 | 0.01 |
| **c) Survey Area** | | | | | | |
| **May-21** | 8 | 47 | 8 | 134 | 0.35 | 0.05 |
| **Jun-21** | 3 | 18 | 3 | 35 | 0.58 | 0.02 |
| **Jul-21** | 2 | 12 | 2 | 30 | 0.71 | 0.01 |
| **Aug-21** | 3 | 17 | 3 | 46 | 0.58 | 0.02 |
| **Sep-21** | 2 | 12 | 2 | 29 | 0.71 | 0.01 |
| **Oct-21** | 1 | 6 | 1 | 18 | 1.00 | 0.01 |
| **Dec-21** | 6 | 35 | 12 | 64 | 0.41 | 0.04 |
| **Jan-22** | 5 | 29 | 12 | 46 | 0.45 | 0.03 |
| **Feb-22** | 1 | 5 | 1 | 16 | 1.00 | 0.01 |
| **Mar-22** | 1 | 5 | 1 | 16 | 1.00 | 0.01 |
| **May-22** | 3 | 17 | 3 | 35 | 0.58 | 0.02 |
| **Jun-22** | 4 | 23 | 4 | 52 | 0.50 | 0.03 |
| **Jul-22** | 9 | 53 | 23 | 82 | 0.33 | 0.06 |
| **Aug-22** | 1 | 6 | 1 | 17 | 1.00 | 0.01 |
| **Sep-22** | 1 | 6 | 1 | 18 | 1.00 | 0.01 |
| **Oct-22** | 2 | 12 | 2 | 29 | 0.71 | 0.01 |
| **Nov-22** | 1 | 6 | 1 | 18 | 1.00 | 0.01 |
| **Dec-22** | 1 | 6 | 1 | 18 | 1.00 | 0.01 |

In Caledonia North Survey Area, peak numbers were recorded in July 2022, with 6 individuals recorded (Table 120). This resulted in a mean abundance estimate of 35 [6; 64] individuals, which equated to a mean density estimate of 0.06 birds/km$^2$ (Table 120).

**Table 120 Raw counts, unapportioned abundance and density estimates (birds per km²) of unidentified bird species in Caledonia North, Caledonia North plus 2 km buffer and Caledonia North Survey Area during the May 2021 to April 2023 survey period**

| Survey | Raw count | Total unapportioned | | | | |
|---|---|---|---|---|---|---|
| | | Abundance | LCL | UCL | Precision (CV) | Density (km²) |
| **a) Caledonia North** | | | | | | |
| **Jun-21** | 1 | 6 | 1 | 18 | 1.00 | 0.03 |
| **Aug-21** | 2 | 12 | 2 | 35 | 0.71 | 0.05 |
| **Sep-21** | 1 | 6 | 1 | 17 | 1.00 | 0.03 |
| **Dec-21** | 1 | 6 | 1 | 17 | 1.00 | 0.03 |
| **Jan-22** | 1 | 6 | 1 | 17 | 1.00 | 0.03 |
| **May-22** | 2 | 12 | 2 | 29 | 0.71 | 0.05 |
| **Jun-22** | 1 | 6 | 1 | 17 | 1.00 | 0.03 |
| **Jul-22** | 3 | 18 | 3 | 41 | 0.58 | 0.08 |
| **Aug-22** | 1 | 6 | 1 | 17 | 1.00 | 0.03 |
| **Sep-22** | 1 | 6 | 1 | 17 | 1.00 | 0.03 |
| **Nov-22** | 1 | 6 | 1 | 18 | 1.00 | 0.03 |
| **b) Caledonia North plus 2 km buffer** | | | | | | |
| **Jun-21** | 2 | 12 | 2 | 29 | 0.71 | 0.03 |
| **Aug-21** | 2 | 11 | 2 | 34 | 0.71 | 0.03 |
| **Sep-21** | 2 | 11 | 2 | 28 | 0.71 | 0.03 |
| **Dec-21** | 2 | 11 | 2 | 28 | 0.71 | 0.03 |
| **Jan-22** | 1 | 6 | 1 | 17 | 1.00 | 0.02 |
| **Feb-22** | 1 | 5 | 1 | 16 | 1.00 | 0.01 |
| **May-22** | 2 | 11 | 2 | 28 | 0.71 | 0.03 |
| **Jun-22** | 1 | 6 | 1 | 17 | 1.00 | 0.02 |
| **Jul-22** | 4 | 23 | 4 | 52 | 0.50 | 0.06 |
| **Aug-22** | 1 | 6 | 1 | 17 | 1.00 | 0.02 |
| **Sep-22** | 1 | 6 | 1 | 17 | 1.00 | 0.02 |
| **Nov-22** | 1 | 6 | 1 | 17 | 1.00 | 0.02 |
| **Dec-22** | 1 | 6 | 1 | 18 | 1.00 | 0.02 |
| **c) Caledonia North Survey Area** | | | | | | |
| **Jun-21** | 2 | 12 | 2 | 30 | 0.71 | 0.02 |
| **Jul-21** | 1 | 6 | 1 | 18 | 1.00 | 0.01 |
| **Aug-21** | 2 | 12 | 2 | 35 | 0.71 | 0.02 |
| **Sep-21** | 2 | 12 | 2 | 29 | 0.71 | 0.02 |
| **Dec-21** | 3 | 17 | 3 | 35 | 0.58 | 0.03 |
| **Jan-22** | 2 | 12 | 2 | 29 | 0.71 | 0.02 |
| **Feb-22** | 1 | 6 | 1 | 17 | 1.00 | 0.01 |
| **Mar-22** | 1 | 5 | 1 | 16 | 1.00 | 0.01 |
| **May-22** | 3 | 17 | 3 | 35 | 0.58 | 0.03 |
| **Jun-22** | 2 | 12 | 2 | 29 | 0.71 | 0.02 |
| **Jul-22** | 6 | 35 | 6 | 64 | 0.41 | 0.06 |
| **Aug-22** | 1 | 6 | 1 | 17 | 1.00 | 0.01 |
| **Sep-22** | 1 | 6 | 1 | 17 | 1.00 | 0.01 |
| **Oct-22** | 1 | 6 | 1 | 18 | 1.00 | 0.01 |
| **Nov-22** | 1 | 6 | 1 | 18 | 1.00 | 0.01 |
| **Dec-22** | 1 | 6 | 1 | 18 | 1.00 | 0.01 |

In Caledonia South Survey Area, peak numbers were recorded in May 2021, with 8 individuals recorded (Table 121). This resulted in a mean abundance estimate of 46 [8; 128] individuals, which equated to a mean density estimate of 0.09 birds/km² (Table 121).

**Table 121 Raw counts, unapportioned abundance and density estimates (birds per km²) of unidentified bird species in Caledonia South, Caledonia South plus 2 km buffer and Caledonia South Survey Area during the May 2021 to April 2023 survey period**

| Survey | Raw count | Total unapportioned | | | | |
|---|---|---|---|---|---|---|
| | | Abundance | LCL | UCL | Precision (CV) | Density (km²) |
| **a) Caledonia South** | | | | | | |
| **May-21** | 1 | 6 | 1 | 17 | 1.00 | 0.03 |
| **Jun-21** | 2 | 12 | 2 | 23 | 0.71 | 0.06 |
| **Aug-21** | 1 | 6 | 1 | 17 | 1.00 | 0.03 |
| **Dec-21** | 2 | 12 | 2 | 35 | 0.71 | 0.06 |
| **Jan-22** | 1 | 6 | 1 | 17 | 1.00 | 0.03 |
| **Jul-22** | 1 | 6 | 1 | 17 | 1.00 | 0.03 |
| **b) Caledonia South plus 2 km buffer** | | | | | | |
| **May-21** | 8 | 46 | 8 | 127 | 0.35 | 0.13 |
| **Jun-21** | 2 | 12 | 2 | 29 | 0.71 | 0.03 |
| **Jul-21** | 1 | 6 | 1 | 17 | 1.00 | 0.02 |
| **Aug-21** | 1 | 6 | 1 | 17 | 1.00 | 0.02 |
| **Oct-21** | 1 | 6 | 1 | 17 | 1.00 | 0.02 |
| **Dec-21** | 2 | 12 | 2 | 35 | 0.71 | 0.03 |
| **Jan-22** | 1 | 6 | 1 | 17 | 1.00 | 0.02 |
| **Jun-22** | 2 | 11 | 2 | 34 | 0.71 | 0.03 |
| **Jul-22** | 2 | 12 | 2 | 29 | 0.71 | 0.03 |
| **c) Caledonia South Survey Area** | | | | | | |
| **May-21** | 8 | 46 | 8 | 128 | 0.35 | 0.09 |
| **Jun-21** | 2 | 12 | 2 | 29 | 0.71 | 0.02 |
| **Jul-21** | 2 | 12 | 2 | 30 | 0.71 | 0.02 |
| **Aug-21** | 1 | 6 | 1 | 17 | 1.00 | 0.01 |
| **Oct-21** | 1 | 6 | 1 | 17 | 1.00 | 0.01 |
| **Dec-21** | 3 | 17 | 3 | 46 | 0.58 | 0.03 |
| **Jan-22** | 3 | 17 | 3 | 35 | 0.58 | 0.03 |
| **May-22** | 1 | 6 | 1 | 17 | 1.00 | 0.01 |
| **Jun-22** | 3 | 17 | 3 | 41 | 0.58 | 0.03 |
| **Jul-22** | 5 | 29 | 6 | 58 | 0.45 | 0.05 |
| **Oct-22** | 1 | 6 | 1 | 18 | 1.00 | 0.01 |

### *ii. Distribution and behaviour*

Distribution maps are shown in Appendix 4: Figure A4.290-308. Unidentified birds were loosely distributed across Caledonia South and its Buffer Zone in May to July 2021 and in April 2022 (Figures A4.290-292, 300), whereas they occurred largely in Caledonia North in August and September 2021 (Figure A4.293-294). In December 2021, January 2022 and May to August 2022, unidentified birds were loosely scattered across the Survey Area (Figures A4.296-297, 301-304). In October 2021, and in February and March 2022, sporadic records were made Zone in the east and west of the Survey Area Buffer (Figures A4.295, 298-299). From September to December 2022, unidentified bird species were found in very low numbers across the Survey Area (Figure A4.305-308).

As very few birds were recorded in flight, they were too infrequent to determine any preference in flight direction (Appendix 5, Figure A5.30).

### 4.37 Deceased birds

Within the Survey Area, 91 deceased birds were recorded during both years of baseline surveys (Table 122). They were recorded in the May to July and September to October 2021, April to September and December 2022 surveys (Table 122).

Whilst it is not uncommon for small numbers of records of deceased birds to be made during surveys of this nature, it is noteworthy that higher numbers of deceased gannets were recorded in the June 2022 and July 2022 surveys (Table 122). It is reasonable to assume that many of these records would have been associated with the outbreak of Highly Pathogenic Avian Influenza (HPAI) reported across many colonies during the 2022 breeding season.

**Table 122 Raw counts of deceased bird species recorded within the Survey Area during the May 2021 to April 2023 survey period**

| Survey | Common gull | Herring gull | Gull species | Guillemot / Razorbill | Fulmar | Gannet | Unidentified bird species | Total |
|---|---|---|---|---|---|---|---|---|
| **May-21** | - | - | 1 | - | - | - | - | **1** |
| **Jun-21** | - | 1 | - | - | - | - | 1 | **2** |
| **Jul-21** | - | - | - | - | - | 1 | - | **1** |
| **Sep-21** | - | - | - | 2 | - | 2 | 1 | **5** |
| **Oct-21** | - | - | - | 2 | - | - | - | **2** |
| **Apr-22** | - | - | - | 1 | - | - | 2 | **3** |
| **May-22** | 1 | - | - | 1 | 3 | 1 | 4 | **10** |
| **Jun-22** | - | - | - | - | - | 9 | 1 | **10** |
| **Jul-22** | - | - | - | 2 | 3 | 38 | 4 | **47** |
| **Aug-22** | - | - | 1 | - | 1 | 1 | 5 | **8** |
| **Sep-22** | - | - | - | - | - | 1 | - | **1** |
| **Dec-22** | - | - | - | - | - | 1 | - | **1** |
| ***Total*** | **1** | **1** | **2** | **8** | **7** | **54** | **18** | **91** |

## 4.38 Grey seal

### *i. Abundance and density estimates*

A total of 26 grey seals were recorded in the Survey Area during both years of baseline surveys (Table 11). Grey seals were recorded in low numbers (≤4) in June 2021, September to November 2021, January 2022, June 2022, and from August 2022 to March 2023 (Table 123). Peak abundance was recorded in October 2022, with 4 individuals resulting in an unapportioned mean abundance estimate of 24 [6; 53] and an apportioned mean abundance estimate of 24 [4; 59] individuals (Table 123). Both equated to a mean density estimate of 0.03 mammals/km$^2$ (Table 123).

Measures of precisions were high (indicating lower levels of precision), which is likely related to the low numbers of individuals recorded in each reporting region during each survey (CV > 0.16; Table 123).

**Table 123 Raw counts, unapportioned and apportioned abundance and density estimates (mammals per km$^2$) of grey seals in Caledonia OWF, Caledonia OWF plus 2 km buffer and the Survey Area during the May 2021 to April 2023 survey period**

| Survey | Raw count | Total unapportioned | | | | | Total apportioned | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Abundance | LCL | UCL | Precision (CV) | Density (km$^2$) | Abundance | LCL | UCL | Density (km$^2$) |
| **a) Caledonia OWF** | | | | | | | | | | |
| **Oct-21** | 1 | 6 | 1 | 18 | 1.00 | 0.01 | 6 | 1 | 18 | 0.01 |
| **Nov-21** | 2 | 12 | 2 | 29 | 0.71 | 0.03 | 12 | 2 | 29 | 0.03 |
| **Jun-22** | 1 | 6 | 1 | 17 | 1.00 | 0.01 | 13 | 2 | 37 | 0.03 |
| **Aug-22** | 1 | 6 | 1 | 17 | 1.00 | 0.01 | 6 | 1 | 17 | 0.01 |
| **Sep-22** | 1 | 6 | 1 | 17 | 1.00 | 0.01 | 6 | 1 | 17 | 0.01 |
| **Oct-22** | 2 | 12 | 2 | 29 | 0.71 | 0.03 | 12 | 2 | 36 | 0.03 |
| **Nov-22** | 0 | - | - | - | - | - | 6 | 1 | 18 | 0.01 |
| **Dec-22** | 1 | 6 | 1 | 18 | 1.00 | 0.01 | 18 | 3 | 47 | 0.04 |
| **Jan-23** | 1 | 6 | 1 | 17 | 1.00 | 0.01 | 6 | 1 | 17 | 0.01 |
| **Feb-23** | 1 | 6 | 1 | 17 | 1.00 | 0.01 | 6 | 1 | 17 | 0.01 |
| **Mar-23** | 1 | 6 | 1 | 18 | 1.00 | 0.01 | 6 | 1 | 18 | 0.01 |
| **b) Caledonia OWF plus 2 km buffer** | | | | | | | | | | |
| **Jun-21** | 1 | 6 | 1 | 17 | 1.00 | 0.01 | 6 | 2 | 34 | 0.01 |
| **Jul-21** | 0 | - | - | - | - | - | - | 1 | 17 | - |
| **Oct-21** | 2 | 12 | 2 | 29 | 0.71 | 0.02 | 12 | 2 | 29 | 0.02 |
| **Nov-21** | 2 | 11 | 2 | 29 | 0.71 | 0.02 | 11 | 2 | 29 | 0.02 |
| **Jan-22** | 1 | 6 | 1 | 17 | 1.00 | 0.01 | 6 | 1 | 17 | 0.01 |
| **Jun-22** | 1 | 6 | 1 | 17 | 1.00 | 0.01 | 12 | 2 | 36 | 0.02 |
| **Aug-22** | 2 | 11 | 2 | 29 | 0.71 | 0.02 | 12 | 2 | 34 | 0.02 |
| **Sep-22** | 1 | 6 | 1 | 17 | 1.00 | 0.01 | 6 | 1 | 17 | 0.01 |
| **Oct-22** | 2 | 12 | 2 | 29 | 0.71 | 0.02 | 12 | 2 | 34 | 0.02 |
| **Nov-22** | 0 | - | - | - | - | - | 6 | 1 | 17 | 0.01 |
| **Dec-22** | 1 | 6 | 1 | 18 | 1.00 | 0.01 | 18 | 3 | 47 | 0.03 |
| **Jan-23** | 1 | 6 | 1 | 17 | 1.00 | 0.01 | 6 | 1 | 17 | 0.01 |
| **Feb-23** | 1 | 6 | 1 | 17 | 1.00 | 0.01 | 6 | 1 | 17 | 0.01 |
| **Mar-23** | 2 | 12 | 2 | 29 | 0.71 | 0.02 | 12 | 2 | 29 | 0.02 |
| **c) Survey Area** | | | | | | | | | | |
| **May-21** | 0 | - | - | - | - | - | 6 | 1 | 18 | 0.01 |
| **Jun-21** | 1 | 6 | 1 | 18 | 1.00 | 0.01 | 18 | 3 | 54 | 0.02 |
| **Jul-21** | 0 | - | - | - | - | - | 12 | 2 | 36 | 0.01 |
| **Sep-21** | 3 | 18 | 3 | 47 | 0.58 | 0.02 | 18 | 3 | 47 | 0.02 |
| **Oct-21** | 2 | 12 | 2 | 29 | 0.71 | 0.01 | 12 | 2 | 29 | 0.01 |
| **Nov-21** | 2 | 12 | 2 | 29 | 0.71 | 0.01 | 12 | 2 | 29 | 0.01 |

| Survey | Raw count | Total unapportioned | | | | | Total apportioned | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Abundance | LCL | UCL | Precision (CV) | Density (km²) | Abundance | LCL | UCL | Density (km²) |
| **Jan-22** | 1 | 6 | 1 | 17 | 1.00 | 0.01 | 6 | 1 | 17 | 0.01 |
| **Jun-22** | 2 | 12 | 2 | 29 | 0.71 | 0.01 | 19 | 3 | 53 | 0.02 |
| **Aug-22** | 2 | 11 | 2 | 29 | 0.71 | 0.01 | 12 | 2 | 34 | 0.01 |
| **Sep-22** | 1 | 6 | 1 | 18 | 1.00 | 0.01 | 6 | 1 | 18 | 0.01 |
| **Oct-22** | 4 | 24 | 6 | 53 | 0.50 | 0.03 | 24 | 4 | 59 | 0.03 |
| **Nov-22** | 1 | 6 | 1 | 18 | 1.00 | 0.01 | 12 | 2 | 36 | 0.01 |
| **Dec-22** | 1 | 6 | 1 | 18 | 1.00 | 0.01 | 18 | 3 | 47 | 0.02 |
| **Jan-23** | 2 | 12 | 2 | 29 | 0.71 | 0.01 | 12 | 2 | 29 | 0.01 |
| **Feb-23** | 2 | 12 | 2 | 29 | 0.71 | 0.01 | 18 | 3 | 46 | 0.02 |
| **Mar-23** | 2 | 12 | 2 | 29 | 0.71 | 0.01 | 18 | 3 | 47 | 0.02 |

A total of 20 grey seals were recorded in Caledonia North Survey Area during both years of baseline surveys (Table 12). Peak abundance was recorded in October 2022 with 4 individuals, resulting in an unapportioned mean abundance estimate of 23 [4; 47] and an apportioned mean abundance estimate of 24 [4; 59] individuals (Table 124). Both equated to a mean density estimate of 0.04 mammals/km$^2$ (Table 124).

Measures of precisions were high (indicating lower levels of precision), which is likely related to the low numbers of individuals recorded in each reporting region during each survey (CV > 0.16; Table 124).

**Table 124 Raw counts, unapportioned and apportioned abundance and density estimates (mammals per km$^2$) of grey seals in Caledonia North, Caledonia North plus 2 km buffer and Caledonia North Survey Area during the May 2021 to April 2023 survey period**

| Survey | Raw count | Total unapportioned | | | | | Total apportioned | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Abundance | LCL | UCL | Precision (CV) | Density (km²) | Abundance | LCL | UCL | Density (km²) |
| **a) Caledonia North** | | | | | | | | | | |
| **Oct-21** | 1 | 6 | 1 | 18 | 1.00 | 0.03 | 6 | 1 | 18 | 0.03 |
| **Oct-22** | 2 | 12 | 2 | 23 | 0.71 | 0.05 | 12 | 2 | 34 | 0.05 |
| **Dec-22** | 1 | 6 | 1 | 17 | 1.00 | 0.03 | 12 | 2 | 34 | 0.05 |
| **Jan-23** | 1 | 6 | 1 | 17 | 1.00 | 0.03 | 6 | 1 | 17 | 0.03 |
| **Feb-23** | 1 | 6 | 1 | 17 | 1.00 | 0.03 | 6 | 1 | 17 | 0.03 |
| **b) Caledonia North plus 2 km buffer** | | | | | | | | | | |
| **Jun-21** | 0 | - | - | - | - | - | 6 | 1 | 17 | 0.02 |
| **Jul-21** | 0 | - | - | - | - | - | 6 | 1 | 17 | 0.02 |
| **Oct-21** | 1 | 6 | 1 | 17 | 1.00 | 0.02 | 6 | 1 | 17 | 0.02 |
| **Jan-22** | 1 | 6 | 1 | 17 | 1.00 | 0.02 | 6 | 1 | 17 | 0.02 |
| **Aug-22** | 2 | 11 | 2 | 29 | 0.71 | 0.03 | 12 | 2 | 34 | 0.03 |
| **Oct-22** | 2 | 12 | 2 | 29 | 0.71 | 0.03 | 12 | 2 | 36 | 0.03 |
| **Dec-22** | 1 | 6 | 1 | 18 | 1.00 | 0.02 | 12 | 2 | 36 | 0.03 |
| **Jan-23** | 1 | 6 | 1 | 18 | 1.00 | 0.02 | 6 | 1 | 19 | 0.02 |
| **Feb-23** | 1 | 6 | 1 | 17 | 1.00 | 0.02 | 6 | 1 | 17 | 0.02 |
| **Mar-23** | 1 | 6 | 1 | 17 | 1.00 | 0.02 | 6 | 1 | 17 | 0.02 |
| **c) Caledonia North Survey Area** | | | | | | | | | | |
| **May-21** | 0 | - | - | - | - | - | 6 | 1 | 18 | 0.01 |
| **Jun-21** | 0 | - | - | - | - | - | 12 | 2 | 36 | 0.02 |
| **Jul-21** | 0 | - | - | - | - | - | 12 | 2 | 36 | 0.02 |
| **Sep-21** | 2 | 12 | 2 | 35 | 0.71 | 0.02 | 12 | 2 | 36 | 0.02 |
| **Oct-21** | 1 | 6 | 1 | 18 | 1.00 | 0.01 | 6 | 1 | 18 | 0.01 |
| **Nov-21** | 1 | 6 | 1 | 18 | 1.00 | 0.01 | 6 | 1 | 18 | 0.01 |

| Survey | Raw count | Total unapportioned | | | | | Total apportioned | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Abundance | LCL | UCL | Precision (CV) | Density (km²) | Abundance | LCL | UCL | Density (km²) |
| **Jan-22** | 1 | 6 | 1 | 17 | 1.00 | 0.01 | 6 | 1 | 17 | 0.01 |
| **Jun-22** | 2 | 12 | 2 | 29 | 0.71 | 0.02 | 13 | 2 | 39 | 0.02 |
| **Aug-22** | 2 | 11 | 2 | 29 | 0.71 | 0.02 | 12 | 2 | 34 | 0.02 |
| **Sep-22** | 1 | 6 | 1 | 17 | 1.00 | 0.01 | 6 | 1 | 17 | 0.01 |
| **Oct-22** | 4 | 23 | 4 | 47 | 0.50 | 0.04 | 24 | 4 | 59 | 0.04 |
| **Nov-22** | 1 | 6 | 1 | 18 | 1.00 | 0.01 | 6 | 1 | 18 | 0.01 |
| **Dec-22** | 1 | 6 | 1 | 18 | 1.00 | 0.01 | 12 | 2 | 36 | 0.02 |
| **Jan-23** | 2 | 12 | 2 | 29 | 0.71 | 0.02 | 12 | 2 | 29 | 0.02 |
| **Feb-23** | 1 | 6 | 1 | 17 | 1.00 | 0.01 | 6 | 1 | 17 | 0.01 |
| **Mar-23** | 1 | 6 | 1 | 18 | 1.00 | 0.01 | 12 | 2 | 36 | 0.02 |

A total of 14 grey seals were recorded in Caledonia South Survey Area during both years of baseline surveys (Table 13). They were recorded in low numbers (≤2), therefore, abundance and density estimates were low (Table 125).

Measures of precisions were high (indicating lower levels of precision), which is likely related to the low numbers of individuals recorded in each reporting region during each survey (CV > 0.16; Table 125).

**Table 125 Raw counts, unapportioned and apportioned abundance and density estimates (mammals per km²) of grey seals in Caledonia South, Caledonia South plus 2 km buffer and Caledonia South Survey Area during the May 2021 to April 2023 survey period**

| Survey | Raw count | Total unapportioned | | | | | Total apportioned | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Abundance | LCL | UCL | Precision (CV) | Density (km²) | Abundance | LCL | UCL | Density (km²) |
| **a) Caledonia South** | | | | | | | | | | |
| **Nov-21** | 2 | 12 | 2 | 29 | 0.71 | 0.06 | 12 | 2 | 29 | 0.06 |
| **Jun-22** | 1 | 6 | 1 | 17 | 1.00 | 0.03 | 12 | 2 | 34 | 0.06 |
| **Aug-22** | 1 | 6 | 1 | 17 | 1.00 | 0.03 | 6 | 1 | 17 | 0.03 |
| **Sep-22** | 1 | 6 | 1 | 17 | 1.00 | 0.03 | 6 | 1 | 17 | 0.03 |
| **Nov-22** | 0 | - | - | - | - | - | 6 | 1 | 17 | 0.03 |
| **Mar-23** | 1 | 6 | 1 | 17 | 1.00 | 0.03 | 6 | 1 | 17 | 0.03 |
| **b) Caledonia South plus 2 km buffer** | | | | | | | | | | |
| **Jun-21** | 1 | 6 | 1 | 17 | 1.00 | 0.02 | 6 | 1 | 17 | 0.02 |
| **Jul-21** | 0 | - | - | - | - | - | 6 | 1 | 17 | 0.02 |
| **Oct-21** | 1 | 6 | 1 | 17 | 1.00 | 0.02 | 6 | 1 | 17 | 0.02 |
| **Nov-21** | 2 | 11 | 2 | 29 | 0.71 | 0.03 | 11 | 2 | 29 | 0.03 |
| **Jun-22** | 1 | 6 | 1 | 17 | 1.00 | 0.02 | 12 | 7 | 34 | 0.03 |
| **Aug-22** | 2 | 11 | 2 | 29 | 0.71 | 0.03 | 12 | 2 | 34 | 0.03 |
| **Sep-22** | 1 | 6 | 1 | 17 | 1.00 | 0.02 | 6 | 1 | 17 | 0.02 |
| **Nov-22** | 0 | - | - | - | - | - | 6 | 6 | 17 | 0.02 |
| **Mar-23** | 1 | 6 | 1 | 17 | 1.00 | 0.02 | 6 | 1 | 17 | 0.02 |
| **c) Caledonia South Survey Area** | | | | | | | | | | |
| **Jun-21** | 1 | 6 | 1 | 17 | 1.00 | 0.01 | 6 | 1 | 17 | 0.01 |
| **Jul-21** | 0 | - | - | - | - | - | 6 | 1 | 18 | 0.01 |
| **Sep-21** | 1 | 6 | 1 | 17 | 1.00 | 0.01 | 6 | 1 | 17 | 0.01 |
| **Oct-21** | 1 | 6 | 1 | 17 | 1.00 | 0.01 | 6 | 1 | 17 | 0.01 |
| **Nov-21** | 2 | 11 | 2 | 29 | 0.71 | 0.02 | 11 | 2 | 29 | 0.02 |
| **Jun-22** | 1 | 6 | 1 | 17 | 1.00 | 0.01 | 12 | 2 | 36 | 0.02 |
| **Aug-22** | 2 | 11 | 2 | 29 | 0.71 | 0.02 | 12 | 2 | 34 | 0.02 |
| **Sep-22** | 1 | 6 | 1 | 18 | 1.00 | 0.01 | 6 | 1 | 18 | 0.01 |

| Survey | Raw count | Total unapportioned | | | | | Total apportioned | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Abundance | LCL | UCL | Precision (CV) | Density (km²) | Abundance | LCL | UCL | Density (km²) |
| **Oct-22** | 1 | 6 | 1 | 18 | 1.00 | 0.01 | 6 | 1 | 18 | 0.01 |
| **Nov-22** | 1 | 6 | 1 | 18 | 1.00 | 0.01 | 12 | 2 | 36 | 0.02 |
| **Dec-22** | 0 | - | - | - | - | - | 6 | 1 | 18 | 0.01 |
| **Feb-23** | 2 | 12 | 2 | 29 | 0.71 | 0.02 | 18 | 3 | 46 | 0.03 |
| **Mar-23** | 1 | 6 | 1 | 17 | 1.00 | 0.01 | 12 | 2 | 34 | 0.02 |

#### *ii. Distribution and behaviour*

Maps of distribution are shown in Appendix 4: Figure A4.309-322. Grey seals were recorded in the Survey Area Buffer Zone in June and September 2021 and January 2022, with records during June in the southeast (Figure A4.309), during September in the northeast and southeast (Figure A4.310), and during January in the northeast (Figure A4.313). In October 2021, grey seals were recorded in the central and southern parts of the Survey Area (Figure A4.311), whereas they were in Caledonia South during November 2021, and September and November 2022 (Figures A4.312, 316, 318) and in Caledonia North during October and December 2022 and January 2023 (Figure A4.317, 319-320). In August 2022, two individuals were recorded in the northeast close to the subdivision line between Caledonia North and South (Figure A4.315). Grey seals were recorded in the northeast and southwest in February 2023 and in the north and southeast in March 2023 (Figure A4.321-322).

### 4.39 Unidentified seal species

#### *i. Abundance and density estimates*

A total of 13 unidentified seals were recorded in the Survey Area during both years of baseline surveys (Table 11). They were recorded in low numbers (≤2), therefore, abundance and density estimates were very low (Table 126).

**Table 126 Raw counts, unapportioned abundance and density estimates (mammals per km²) of seal species in Caledonia OWF, Caledonia OWF plus 2 km buffer and the Survey Area during the May 2021 to April 2023 survey period**

| Survey | Raw count | Total unapportioned | | | | |
|---|---|---|---|---|---|---|
| | | Abundance | LCL | UCL | Precision (CV) | Density (km²) |
| **a) Caledonia OWF** | | | | | | |
| **Mar-22** | 1 | 5 | 1 | 16 | 1.00 | 0.01 |
| **Jun-22** | 1 | 6 | 1 | 17 | 1.00 | 0.01 |
| **Nov-22** | 1 | 6 | 1 | 18 | 1.00 | 0.01 |
| **Dec-22** | 2 | 12 | 2 | 29 | 0.71 | 0.03 |
| **b) Caledonia OWF plus 2 km** | | | | | | |
| **Jun-21** | 1 | 6 | 1 | 17 | 1.00 | 0.01 |
| **Jul-21** | 1 | 6 | 1 | 17 | 1.00 | 0.01 |
| **Feb-22** | 1 | 5 | 1 | 16 | 1.00 | 0.01 |
| **Mar-22** | 1 | 5 | 1 | 16 | 1.00 | 0.01 |
| **Jun-22** | 1 | 6 | 1 | 17 | 1.00 | 0.01 |
| **Nov-22** | 1 | 6 | 1 | 17 | 1.00 | 0.01 |
| **Dec-22** | 2 | 12 | 2 | 29 | 0.71 | 0.02 |
| **c) Survey Area** | | | | | | |
| **May-21** | 1 | 6 | 1 | 18 | 1.00 | 0.01 |
| **Jun-21** | 2 | 12 | 2 | 29 | 0.71 | 0.01 |
| **Jul-21** | 2 | 12 | 2 | 30 | 0.71 | 0.01 |
| **Feb-22** | 1 | 5 | 1 | 16 | 1.00 | 0.01 |
| **Mar-22** | 1 | 5 | 1 | 16 | 1.00 | 0.01 |
| **Jun-22** | 1 | 6 | 1 | 17 | 1.00 | 0.01 |

| Survey | Raw count | Total unapportioned | | | | |
|---|---|---|---|---|---|---|
| | | Abundance | LCL | UCL | Precision (CV) | Density (km²) |
| **Nov-22** | 1 | 6 | 1 | 18 | 1.00 | 0.01 |
| **Dec-22** | 2 | 12 | 2 | 29 | 0.71 | 0.01 |
| **Feb-23** | 1 | 6 | 1 | 17 | 1.00 | 0.01 |
| **Mar-23** | 1 | 6 | 1 | 18 | 1.00 | 0.01 |

A total of eight unidentified seals were recorded in Caledonia North Survey Area during both years of baseline surveys (Table 12). They were recorded in low numbers (≤2), therefore, abundance estimates were very low (**Error! Not a valid bookmark self-reference.**).

**Table 127 Raw counts, unapportioned abundance and density estimates (mammals per km²) of seal species in Caledonia North, Caledonia North plus 2 km buffer and Caledonia North Survey Area during the May 2021 to April 2023 survey period**

| Survey | Raw count | Total unapportioned | | | | |
|---|---|---|---|---|---|---|
| | | Abundance | LCL | UCL | Precision (CV) | Density (km²) |
| **a) Caledonia North** | | | | | | |
| **Dec-22** | 1 | 6 | 1 | 17 | 1.00 | 0.03 |
| **b) Caledonia North plus 2 km buffer** | | | | | | |
| **Jun-21** | 1 | 6 | 1 | 17 | 1.00 | 0.02 |
| **Jul-21** | 1 | 6 | 1 | 17 | 1.00 | 0.02 |
| **Feb-22** | 1 | 5 | 1 | 16 | 1.00 | 0.01 |
| **Dec-22** | 1 | 6 | 1 | 18 | 1.00 | 0.02 |
| **c) Caledonia North Survey Area** | | | | | | |
| **May-21** | 1 | 6 | 1 | 18 | 1.00 | 0.01 |
| **Jun-21** | 2 | 12 | 2 | 30 | 0.71 | 0.02 |
| **Jul-21** | 2 | 12 | 2 | 30 | 0.71 | 0.02 |
| **Feb-22** | 1 | 6 | 1 | 17 | 1.00 | 0.01 |
| **Dec-22** | 1 | 6 | 1 | 18 | 1.00 | 0.01 |
| **Mar-23** | 1 | 6 | 1 | 18 | 1.00 | 0.01 |

A total of seven unidentified seals were recorded in Caledonia South Survey Area during both years of baseline surveys (Table 13). They were recorded in low numbers (≤1), therefore, abundance and density estimates were very low (**Error! Not a valid bookmark self-reference.**).

**Table 128 Raw counts, unapportioned abundance and density estimates (mammals per km²) of seal species in Caledonia South, Caledonia South plus 2 km buffer and Caledonia South Survey Area during the May 2021 to April 2023 survey period**

| Survey | Raw count | Total unapportioned | | | | |
|---|---|---|---|---|---|---|
| | | Abundance | LCL | UCL | Precision (CV) | Density (km²) |
| **a) Caledonia South** | | | | | | |
| **Mar-22** | 1 | 5 | 1 | 16 | 1.00 | 0.02 |
| **Jun-22** | 1 | 6 | 1 | 17 | 1.00 | 0.03 |
| **Nov-22** | 1 | 6 | 1 | 18 | 1.00 | 0.03 |
| **Dec-22** | 1 | 6 | 1 | 18 | 1.00 | 0.03 |
| **b) Caledonia South plus 2 km buffer** | | | | | | |
| **Jul-21** | 1 | 6 | 1 | 17 | 1.00 | 0.02 |
| **Mar-22** | 1 | 5 | 1 | 16 | 1.00 | 0.01 |
| **Jun-22** | 1 | 6 | 1 | 17 | 1.00 | 0.02 |
| **Nov-22** | 1 | 6 | 1 | 17 | 1.00 | 0.02 |
| **Dec-22** | 1 | 6 | 1 | 17 | 1.00 | 0.02 |
| **c) Caledonia South Survey Area** | | | | | | |
| **Jul-21** | 1 | 6 | 1 | 18 | 1.00 | 0.01 |
| **Mar-22** | 1 | 5 | 1 | 16 | 1.00 | 0.01 |
| **Jun-22** | 1 | 6 | 1 | 17 | 1.00 | 0.01 |

| Survey | Raw count | Total unapportioned | | | | |
|---|---|---|---|---|---|---|
| | | Abundance | LCL | UCL | Precision (CV) | Density (km²) |
| **Nov-22** | 1 | 6 | 1 | 18 | 1.00 | 0.01 |
| **Dec-22** | 1 | 6 | 1 | 18 | 1.00 | 0.01 |
| **Feb-23** | 1 | 6 | 1 | 17 | 1.00 | 0.01 |
| **Mar-23** | 1 | 6 | 1 | 17 | 1.00 | 0.01 |

#### *ii. Distribution and behaviour*

Maps of distribution are shown in Appendix 4: Figures A4.323-332. From May to July 2021, seal species occurred only in Caledonia North Buffer Zone, with most individuals in the northeast (Figures A4.323-325). The individual in February 2022 was located close to the most southerly turbine of the Moray East offshore wind farm within Caledonia North, close to the 4 km buffer of Caledonia South (Figure A4.326). In March, June, November, December 2022, and in February and March 2023, the majority of individuals were recorded in Caledonia South though one individual during December 2022 occurred in Caledonia North (Figure A4.327-332).

### 4.40 Common dolphin

#### *i. Abundance and density estimates*

A total of 39 common dolphins were recorded in the Survey Area in October 2022 (Table 11, Table 129). They were only recorded in the 4 km Buffer Zone of the Survey Area, specifically in Caledonia South Buffer Zone (Table 129, Table 131). This resulted in an unapportioned mean abundance estimate of 229 [39; 687-688] and an apportioned mean abundance of 238 [41; 715-723] individuals in the Survey Area and Caledonia South Survey Area (Table 129, Table 131). These equated to mean density estimates of 0.26 (unapportioned) and 0.27 (apportioned) mammals/km$^2$ in the Survey Area and 0.43 (unapportioned) and 0.45 (apportioned) mammals/km$^2$ in Caledonia South Survey Area (Table 129, Table 131). No records of common dolphins were recorded in Caledonia North Survey Area (Table 12, Table 130).

Measures of precisions were high (indicating lower levels of precision), which is likely related to the low numbers of individuals recorded in each reporting region during each survey (CV > 0.16; Table 129 to Table 131).

**Table 129 Raw counts, unapportioned and apportioned abundance and density estimates (mammals per km$^2$) of common dolphins in Caledonia OWF, Caledonia OWF plus 2 km buffer and the Survey Area during the May 2021 to April 2023 survey period**

| Survey | Raw count | Total unapportioned | | | | | Total apportioned | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Abundance | LCL | UCL | Precision (CV) | Density (km²) | Abundance | LCL | UCL | Density (km²) |
| **a) Caledonia OWF** | | | | | | | | | | |
| None recorded | | | | | | | | | | |
| **b) Caledonia OWF plus 2 km buffer** | | | | | | | | | | |
| None recorded | | | | | | | | | | |
| **c) Survey Area** | | | | | | | | | | |
| **Oct-22** | 39 | 229 | 39 | 688 | 0.16 | 0.26 | 238 | 41 | 715 | 0.27 |

**Table 130 Raw counts, unapportioned and apportioned abundance and density estimates (mammals per km$^2$) of common dolphins in Caledonia North, Caledonia North plus 2 km buffer and Caledonia North Survey Area during the May 2021 to April 2023 survey period**

| Survey | Raw count | Total unapportioned | | | | | Total apportioned | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Abundance | LCL | UCL | Precision (CV) | Density (km$^2$) | Abundance | LCL | UCL | Density (km$^2$) |
| **a) Caledonia North** | | | | | | | | | | |
| None recorded | | | | | | | | | | |
| **b) Caledonia North plus 2 km buffer** | | | | | | | | | | |
| None recorded | | | | | | | | | | |
| **c) Caledonia North Survey Area** | | | | | | | | | | |
| None recorded | | | | | | | | | | |

**Table 131 Raw counts, unapportioned and apportioned abundance and density estimates (mammals per km$^2$) of common dolphins in Caledonia South, Caledonia South plus 2 km buffer and Caledonia South Survey Area during the May 2021 to April 2023 survey period**

| Survey | Raw count | Total unapportioned | | | | | Total apportioned | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Abundance | LCL | UCL | Precision (CV) | Density (km$^2$) | Abundance | LCL | UCL | Density (km$^2$) |
| **a) Caledonia South** | | | | | | | | | | |
| None recorded | | | | | | | | | | |
| **b) Caledonia South plus 2 km buffer** | | | | | | | | | | |
| **Oct-22** | 6 | 35 | 6 | 104 | 0.41 | 0.10 | 41 | 12 | 121 | 0.11 |
| **c) Caledonia South Survey Area** | | | | | | | | | | |
| **Oct-22** | 39 | 229 | 39 | 687 | 0.16 | 0.43 | 241 | 41 | 723 | 0.45 |

#### *ii. Distribution and behaviour*

Common dolphins were only recorded during October 2022, when they were recorded in the southwest of the Survey Area within Caledonia South Buffer Zone (Appendix 4, Figure A4.333).

### 4.41 White-beaked dolphin

#### *i. Abundance and density estimates*

A total of 64 white-beaked dolphins were recorded in the Survey Area during both years of baseline surveys (Table 11). White-beaked dolphins were recorded from September 2021 to February 2022, September and October 2022 and January and February 2023 (Table 11, Table 132). In the Survey Area, a peak of 14 white-beaked dolphins were recorded in September 2022, resulting in an unapportioned mean abundance estimate of 82 [14; 175] and an apportioned mean abundance estimate of 81 [14; 187] individuals (Table 132). Both equated to a mean density estimate of 0.09 mammals/km$^2$ (Table 132).

Measures of precisions were high (indicating lower levels of precision), which is likely related to the low numbers of individuals recorded in each reporting region during each survey (CV > 0.16; Table 132).

**Table 132 Raw counts, unapportioned and apportioned abundance and density estimates (mammals per km$^2$) of white-beaked dolphins in Caledonia OWF, Caledonia OWF plus 2 km buffer and the Survey Area during the May 2021 to April 2023 survey period**

| Survey | Raw count | Total unapportioned | | | | | Total apportioned | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Abundance | LCL | UCL | Precision (CV) | Density (km$^2$) | Abundance | LCL | UCL | Density (km$^2$) |
| **a)** | **Caledonia OWF** | | | | | | | | | |
| **Oct-21** | 2 | 12 | 2 | 35 | 0.71 | 0.03 | 20 | 3 | 65 | 0.05 |
| **Nov-21** | 8 | 46 | 8 | 116 | 0.35 | 0.11 | 52 | 9 | 127 | 0.12 |
| **Dec-21** | 7 | 41 | 7 | 122 | 0.38 | 0.10 | 41 | 7 | 122 | 0.1 |
| **Jan-22** | 0 | - | - | - | - | - | 18 | 3 | 52 | 0.04 |
| **Feb-22** | 4 | 22 | 4 | 65 | 0.50 | 0.05 | 32 | 6 | 97 | 0.07 |
| **Sep-22** | 14 | 81 | 14 | 162 | 0.27 | 0.19 | 81 | 16 | 174 | 0.19 |
| **Oct-22** | 2 | 12 | 2 | 35 | 0.71 | 0.03 | 18 | 3 | 53 | 0.04 |
| **Jan-23** | 2 | 12 | 2 | 35 | 0.71 | 0.03 | 12 | 2 | 35 | 0.03 |
| **Feb-23** | 6 | 34 | 6 | 103 | 0.41 | 0.08 | 34 | 6 | 103 | 0.08 |
| **b)** | **Caledonia OWF plus 2 km buffer** | | | | | | | | | |
| **Oct-21** | 2 | 12 | 2 | 35 | 0.71 | 0.02 | 20 | 3 | 63 | 0.03 |
| **Nov-21** | 8 | 46 | 8 | 109 | 0.35 | 0.07 | 63 | 11 | 155 | 0.1 |
| **Dec-21** | 7 | 40 | 7 | 120 | 0.38 | 0.06 | 40 | 7 | 120 | 0.06 |
| **Jan-22** | 0 | - | - | - | - | - | 14 | 3 | 43 | 0.02 |
| **Feb-22** | 4 | 21 | 4 | 64 | 0.50 | 0.03 | 32 | 6 | 96 | 0.05 |
| **Sep-22** | 14 | 81 | 23 | 173 | 0.27 | 0.13 | 81 | 16 | 179 | 0.13 |
| **Oct-22** | 2 | 12 | 2 | 35 | 0.71 | 0.02 | 18 | 3 | 52 | 0.03 |
| **Dec-22** | 0 | - | - | - | - | - | 3 | 0 | 10 | - |
| **Jan-23** | 2 | 12 | 2 | 35 | 0.71 | 0.02 | 12 | 2 | 35 | 0.02 |
| **Feb-23** | 6 | 34 | 6 | 103 | 0.41 | 0.05 | 34 | 6 | 103 | 0.05 |
| **c)** | **Survey Area** | | | | | | | | | |
| **Sep-21** | 2 | 12 | 2 | 35 | 0.71 | 0.01 | 20 | 3 | 54 | 0.02 |
| **Oct-21** | 2 | 12 | 2 | 35 | 0.71 | 0.01 | 20 | 3 | 64 | 0.02 |
| **Nov-21** | 8 | 47 | 8 | 116 | 0.35 | 0.05 | 82 | 14 | 198 | 0.09 |
| **Dec-21** | 7 | 41 | 7 | 122 | 0.38 | 0.05 | 41 | 7 | 122 | 0.05 |
| **Jan-22** | 3 | 17 | 3 | 52 | 0.58 | 0.02 | 36 | 6 | 104 | 0.04 |
| **Feb-22** | 8 | 44 | 8 | 110 | 0.35 | 0.05 | 53 | 10 | 137 | 0.06 |
| **Sep-22** | 14 | 82 | 14 | 175 | 0.27 | 0.09 | 81 | 14 | 187 | 0.09 |
| **Oct-22** | 9 | 53 | 9 | 135 | 0.33 | 0.06 | 56 | 9 | 155 | 0.06 |
| **Dec-22** | 0 | - | - | - | - | - | 6 | 1 | 18 | 0.01 |
| **Jan-23** | 5 | 29 | 5 | 59 | 0.45 | 0.03 | 30 | 5 | 82 | 0.03 |
| **Feb-23** | 6 | 35 | 6 | 104 | 0.41 | 0.04 | 35 | 6 | 104 | 0.04 |

A total of 43 white-beaked dolphins were recorded in Caledonia North Survey Area during both years of baseline surveys (Table 12). Peak abundance was recorded in October 2022, with 9 individuals recorded (Table 133). This resulted in an unapportioned and apportioned mean abundance estimate of 53 [9; 135] individuals, which both equated to a mean density estimate of 0.10 mammals/km$^2$ (Table 133).

Measures of precisions were high (indicating lower levels of precision), which is likely related to the low numbers of individuals recorded in each reporting region during each survey (CV > 0.16; Table 133).

**Table 133 Raw counts, unapportioned and apportioned abundance and density estimates (mammals per km$^2$) of white-beaked dolphins in Caledonia North, Caledonia North plus 2 km buffer and Caledonia North Survey Area during the May 2021 to April 2023 survey period**

| Survey | Raw count | Total unapportioned | | | | | Total apportioned | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Abundance | LCL | UCL | Precision (CV) | Density (km$^2$) | Abundance | LCL | UCL | Density (km$^2$) |
| **a) Caledonia North** | | | | | | | | | | |
| **Oct-21** | 2 | 12 | 2 | 35 | 0.71 | 0.05 | 36 | 6 | 105 | 0.16 |
| **Nov-21** | 3 | 18 | 3 | 53 | 0.58 | 0.08 | 18 | 3 | 53 | 0.08 |
| **Sep-22** | 8 | 46 | 8 | 92 | 0.35 | 0.21 | 46 | 8 | 109 | 0.21 |
| **Oct-22** | 2 | 12 | 2 | 35 | 0.71 | 0.05 | 12 | 2 | 35 | 0.05 |
| **Jan-23** | 2 | 12 | 2 | 35 | 0.71 | 0.05 | 12 | 2 | 35 | 0.05 |
| **Feb-23** | 6 | 35 | 6 | 104 | 0.41 | 0.16 | 35 | 6 | 104 | 0.16 |
| **b) Caledonia North plus 2 km buffer** | | | | | | | | | | |
| **Oct-21** | 2 | 11 | 2 | 34 | 0.71 | 0.03 | 29 | 5 | 97 | 0.08 |
| **Nov-21** | 3 | 17 | 3 | 51 | 0.58 | 0.05 | 23 | 4 | 68 | 0.06 |
| **Feb-22** | 4 | 21 | 4 | 64 | 0.50 | 0.06 | 21 | 4 | 64 | 0.06 |
| **Sep-22** | 8 | 46 | 8 | 116 | 0.35 | 0.12 | 46 | 8 | 111 | 0.12 |
| **Oct-22** | 2 | 12 | 2 | 35 | 0.71 | 0.03 | 12 | 2 | 35 | 0.03 |
| **Jan-23** | 2 | 12 | 2 | 35 | 0.71 | 0.03 | 12 | 2 | 35 | 0.03 |
| **Feb-23** | 6 | 34 | 6 | 103 | 0.41 | 0.09 | 34 | 6 | 103 | 0.09 |
| **c) Caledonia North Survey Area** | | | | | | | | | | |
| **Oct-21** | 2 | 12 | 2 | 35 | 0.71 | 0.02 | 21 | 3 | 64 | 0.04 |
| **Nov-21** | 8 | 47 | 8 | 111 | 0.35 | 0.08 | 70 | 12 | 181 | 0.13 |
| **Feb-22** | 8 | 44 | 8 | 110 | 0.35 | 0.08 | 55 | 10 | 139 | 0.10 |
| **Sep-22** | 8 | 47 | 8 | 116 | 0.35 | 0.08 | 46 | 8 | 117 | 0.08 |
| **Oct-22** | 9 | 53 | 9 | 135 | 0.33 | 0.10 | 53 | 9 | 135 | 0.10 |
| **Jan-23** | 2 | 12 | 2 | 35 | 0.71 | 0.02 | 12 | 2 | 35 | 0.02 |
| **Feb-23** | 6 | 35 | 6 | 104 | 0.41 | 0.06 | 35 | 6 | 104 | 0.06 |

A total of 37 white-beaked dolphins were recorded in Caledonia South Survey Area during both years of baseline surveys (Table 13). Peak abundance was recorded in November 2021 and February 2022, both with 8 individuals recorded. This resulted in an unapportioned mean abundance estimate of 46 [8; 121] and an apportioned mean abundance estimate of 63 [11; 161] individuals in In November 2021 (Table 134), which equated to mean density estimates of 0.09 (unapportioned) and 0.12 (apportioned) mammals/km$^2$ (Table 134). In February, the eight individuals recorded resulted in an unapportioned mean abundance estimate of 43 [8; 109] and apportioned mean abundance estimate of 54 [10; 141] individuals (Table 134). These equated to mean density estimates of 0.08 (unapportioned) and 0.10 (apportioned) mammals/km$^2$ (Table 134).

Measures of precisions were high (indicating lower levels of precision), which is likely related to the low numbers of individuals recorded in each reporting region during each survey (CV > 0.16; Table 134).

**Table 134 Raw counts, unapportioned and apportioned abundance and density estimates (mammals per km$^2$) of white-beaked dolphins in Caledonia South, Caledonia South plus 2 km buffer and Caledonia South Survey Area during the May 2021 to April 2023 survey period**

| Survey | Raw count | Total unapportioned | | | | | Total apportioned | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Abundance | LCL | UCL | Precision (CV) | Density (km$^2$) | Abundance | LCL | UCL | Density (km$^2$) |
| **a) Caledonia South** | | | | | | | | | | |
| **Nov-21** | 5 | 29 | 5 | 86 | 0.45 | 0.14 | 35 | 6 | 103 | 0.17 |
| **Dec-21** | 7 | 41 | 7 | 122 | 0.38 | 0.19 | 41 | 7 | 122 | 0.19 |

| Survey | Raw count | Total unapportioned | | | | | Total apportioned | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Abundance | LCL | UCL | Precision (CV) | Density (km²) | Abundance | LCL | UCL | Density (km²) |
| **Jan-22** | - | - | - | - | - | - | 18 | 3 | 52 | 0.09 |
| **Feb-22** | 4 | 22 | 4 | 65 | 0.50 | 0.10 | 32 | 6 | 97 | 0.15 |
| **Sep-22** | 6 | 35 | 6 | 105 | 0.41 | 0.17 | 35 | 6 | 104 | 0.17 |
| **Oct-22** | - | - | - | - | - | - | 4 | 1 | 12 | 0.02 |
| **b) Caledonia South plus 2 km buffer** | | | | | | | | | | |
| **Sep-21** | - | - | - | - | - | - | 3 | 3 | 10 | 0.01 |
| **Nov-21** | 8 | 46 | 8 | 114 | 0.35 | 0.13 | 63 | 25 | 155 | 0.18 |
| **Dec-21** | 7 | 40 | 7 | 121 | 0.38 | 0.11 | 40 | 7 | 121 | 0.11 |
| **Jan-22** | - | - | - | - | - | - | 17 | 17 | 51 | 0.05 |
| **Feb-22** | 4 | 21 | 4 | 64 | 0.50 | 0.06 | 32 | 15 | 96 | 0.09 |
| **Sep-22** | 6 | 34 | 6 | 103 | 0.41 | 0.09 | 35 | 6 | 103 | 0.10 |
| **c) Caledonia South Survey Area** | | | | | | | | | | |
| **Sep-21** | 2 | 12 | 2 | 35 | 0.71 | 0.02 | 18 | 3 | 52 | 0.03 |
| **Nov-21** | 8 | 46 | 8 | 121 | 0.35 | 0.09 | 63 | 11 | 161 | 0.12 |
| **Dec-21** | 7 | 40 | 7 | 121 | 0.38 | 0.07 | 40 | 7 | 121 | 0.07 |
| **Jan-22** | 3 | 17 | 3 | 52 | 0.58 | 0.03 | 36 | 6 | 104 | 0.07 |
| **Feb-22** | 8 | 43 | 8 | 109 | 0.35 | 0.08 | 54 | 10 | 141 | 0.10 |
| **Sep-22** | 6 | 35 | 6 | 105 | 0.41 | 0.07 | 35 | 6 | 106 | 0.07 |
| **Jan-23** | 3 | 18 | 3 | 41 | 0.58 | 0.03 | 18 | 3 | 41 | 0.03 |

#### *ii. Distribution and behaviour*

Maps of distribution are shown in Appendix 4: Figures A4.334-343. White-beaked dolphins were overall loosely scattered across the Survey Area with a higher number of records in Caledonia South. They were recorded in the southeast during September 2021 (Figure A4.334), in central and southwestern areas close to the subdivision boundary between Caledonia North and South in October and November 2021, and February and September 2022 (Figures A4.335-336, 339-340), in the south in December 2021 (Figure A4.337), in the northeast to east in January and October 2022 (Figure A4.338, 341), and north in February 2023 (Figure A4.343). Individuals were more loosely distributed across both northern and southern parts of the Survey Area in January 2023 (Figure A4.342).

### 4.42 Bottlenose dolphin

#### *i. Abundance and density estimates*

Two bottlenose dolphins were recorded in Caledonia OWF in May 2022, specifically in Caledonia North (Table 11, Table 12, Table 135, Table 136). The abundance and density estimates were therefore very low (Table 135 to Table 136). No records of bottlenose dolphins in Caledonia South Survey Area were made (Table 137).

Measures of precisions were high (indicating lower levels of precision), which is likely related to the low numbers of individuals recorded in each reporting region during each survey (CV > 0.16; Table 135 to Table 137).

**Table 135 Raw counts, unapportioned and apportioned abundance and density estimates (mammals per km²) of bottlenose dolphins in Caledonia OWF, Caledonia OWF plus 2 km buffer and the Survey Area during the May 2021 to April 2023 survey period**

| Survey | Raw count | Total unapportioned | | | | | Total apportioned | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Abundance | LCL | UCL | Precision (CV) | Density (km²) | Abundance | LCL | UCL | Density (km²) |
| **a) Caledonia OWF** | | | | | | | | | | |
| **May-22** | 2 | 12 | 2 | 35 | 0.71 | 0.03 | 14 | 2 | 42 | 0.03 |

| Survey | Raw count | Total unapportioned | | | | | Total apportioned | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Abundance | LCL | UCL | Precision (CV) | Density (km²) | Abundance | LCL | UCL | Density (km²) |
| b) Caledonia OWF plus 2 km buffer | | | | | | | | | | |
| May-22 | 2 | 11 | 2 | 34 | 0.71 | 0.02 | 12 | 2 | 40 | 0.02 |
| c) Survey Area | | | | | | | | | | |
| May-22 | 2 | 12 | 2 | 35 | 0.71 | 0.01 | 13 | 2 | 40 | 0.02 |

**Table 136 Raw counts, unapportioned abundance and density estimates (mammals per km²) of bottlenose dolphins in Caledonia North, Caledonia North plus 2 km buffer and Caledonia North Survey Area during the May 2021 to April 2023 survey period**

| Survey | Raw count | Total unapportioned | | | | | Total apportioned | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Abundance | LCL | UCL | Precision (CV) | Density (km²) | Abundance | LCL | UCL | Density (km²) |
| a) Caledonia North | | | | | | | | | | |
| May-22 | 2 | 12 | 2 | 35 | 0.71 | 0.05 | 12 | 2 | 35 | 0.05 |
| b) Caledonia North plus 2 km buffer | | | | | | | | | | |
| May-22 | 2 | 11 | 2 | 34 | 0.71 | 0.03 | 11 | 2 | 34 | 0.03 |
| c) Caledonia North Survey Area | | | | | | | | | | |
| May-22 | 2 | 12 | 2 | 35 | 0.71 | 0.02 | 12 | 2 | 35 | 0.05 |

**Table 137 Raw counts, unapportioned abundance and density estimates (mammals per km²) of bottlenose dolphins in Caledonia South, Caledonia South plus 2 km buffer and Caledonia South Survey Area during the May 2021 to April 2023 survey period**

| Survey | Raw count | Total unapportioned | | | | | Total apportioned | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Abundance | LCL | UCL | Precision (CV) | Density (km²) | Abundance | LCL | UCL | Density (km²) |
| a) Caledonia South | | | | | | | | | | |
| None recorded | | | | | | | | | | |
| b) Caledonia South plus 2 km buffer | | | | | | | | | | |
| None recorded | | | | | | | | | | |
| c) Caledonia South Survey Area | | | | | | | | | | |
| None recorded | | | | | | | | | | |

#### *ii. Distribution and behaviour*

Two bottlenose dolphins were recorded in May 2022 within the northwest of the Survey Area towards the western border between Caledonia North and its Buffer Zone (Appendix 4, Figure A4.344).

### 4.43 Risso's dolphin

#### *i. Abundance and density estimates*

A total of seven Risso's dolphins were recorded in the Survey Area during the second year of the baseline surveys (Table 11). Risso's dolphins were recorded in August and September 2022 (Table 11, Table 138). Specifically, two individuals were recorded in August 2022, in Caledonia South and five individuals were recorded in September 2022 in Caledonia North plus 2 km buffer (Table 11 to Table 13, Table 138 to Table 140). Abundance and density estimates were therefore very low in august 2022 (Table 138 to Table 139). In the Survey Area and Caledonia North Survey Area, the September 2022 peak of five Risso's dolphins resulted in an unapportioned and apportioned mean abundance estimate of 29 [5; 87-88] individuals, which equated to mean density estimates of 0.03 mammals/km² in the Survey Area and 0.5 mammals/km² in Caledonia North Survey Area (Table 138 to Table 140).

Measures of precisions were high (indicating lower levels of precision), which is likely related to the low numbers of individuals recorded in each reporting region during each survey (CV > 0.16; Table 138 to Table 140).

**Table 138 Raw counts, unapportioned and apportioned abundance and density estimates (mammals per km$^2$) of Risso's dolphins in Caledonia OWF, Caledonia OWF plus 2 km buffer and the Survey Area during the May 2021 to April 2023 survey period**

| Survey | Raw count | Total unapportioned | | | | | Total apportioned | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Abundance | LCL | UCL | Precision (CV) | Density (km$^2$) | Abundance | LCL | UCL | Density (km$^2$) |
| **a) Caledonia OWF** | | | | | | | | | | |
| **Jun-21** | 0 | - | - | - | - | - | 6 | 1 | 18 | 0.01 |
| **Aug-22** | 2 | 12 | 2 | 35 | 0.71 | 0.03 | 12 | 2 | 34 | 0.03 |
| **b) Caledonia OWF plus 2 km buffer** | | | | | | | | | | |
| **Jun-21** | 0 | - | - | - | - | - | 6 | 1 | 17 | 0.01 |
| **Aug-22** | 2 | 11 | 2 | 34 | 0.71 | 0.02 | 12 | 2 | 34 | 0.02 |
| **Sep-22** | 5 | 29 | 5 | 87 | 0.45 | 0.05 | 29 | 5 | 87 | 0.05 |
| **c) Survey Area** | | | | | | | | | | |
| **Jun-21** | 0 | - | - | - | - | - | 6 | 1 | 18 | 0.01 |
| **Aug-22** | 2 | 11 | 2 | 34 | 0.71 | 0.01 | 12 | 2 | 34 | 0.01 |
| **Sep-22** | 5 | 29 | 5 | 88 | 0.45 | 0.03 | 29 | 5 | 88 | 0.03 |

**Table 139 Raw counts, unapportioned abundance and density estimates (mammals per km$^2$) of Risso's dolphins in Caledonia North, Caledonia North plus 2 km buffer and Caledonia North Survey Area during the May 2021 to April 2023 survey period**

| Survey | Raw count | Total unapportioned | | | | | Total apportioned | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Abundance | LCL | UCL | Precision (CV) | Density (km$^2$) | Abundance | LCL | UCL | Density (km$^2$) |
| **a) Caledonia North** | | | | | | | | | | |
| None recorded | | | | | | | | | | |
| **b) Caledonia North plus 2 km buffer** | | | | | | | | | | |
| **Sep-22** | 5 | 29 | 5 | 87 | 0.45 | 0.08 | 29 | 5 | 87 | 0.08 |
| **c) Caledonia North Survey Area** | | | | | | | | | | |
| **Sep-22** | 5 | 29 | 5 | 87 | 0.45 | 0.05 | 29 | 5 | 87 | 0.05 |

**Table 140 Raw counts, unapportioned abundance and density estimates (mammals per km$^2$) of Risso's dolphins in Caledonia South, Caledonia South plus 2 km buffer and Caledonia South Survey Area during the May 2021 to April 2023 survey period**

| Survey | Raw count | Total unapportioned | | | | | Total apportioned | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Abundance | LCL | UCL | Precision (CV) | Density (km$^2$) | Abundance | LCL | UCL | Density (km$^2$) |
| **a) Caledonia South** | | | | | | | | | | |
| **Aug-22** | 2 | 12 | 2 | 35 | 0.71 | 0.06 | 12 | 2 | 34 | 0.06 |
| **b) Caledonia South plus 2 km buffer** | | | | | | | | | | |
| **Jun-21** | - | - | - | - | - | - | 6 | 6 | 17 | 0.02 |
| **Aug-22** | 2 | 11 | 2 | 34 | 0.71 | 0.03 | 12 | 2 | 34 | 0.03 |
| **c) Caledonia South Survey Area** | | | | | | | | | | |
| **Jun-21** | - | - | - | - | - | - | 6 | 1 | 17 | 0.01 |
| **Aug-22** | 2 | 11 | 2 | 34 | 0.71 | 0.02 | 12 | 2 | 34 | 0.02 |

### *ii. Distribution and behaviour*

Risso's dolphins were recorded in the southeast of the Survey Area within Caledonia South during August 2022 (Appendix 4, Figure A4.345), while individuals recorded in September 2022 occurred in the northwest of Caledonia North Buffer Zone close to the boundary with the Caledonia North (Appendix 4, Figure A4.346).

## 4.44 Unidentified dolphin species

### *i. Abundance and density estimates*

Three unidentified dolphins were recorded in the Survey Area during the first year of surveys, none were recorded the second year of surveys (Table 11). A single unidentified dolphin was recorded in June 2021 in Caledonia North, while two individuals were recorded in January 2022 in Caledonia South (Table 141 to Table 143). In both months, abundance and density estimates were therefore very low (Table 141 to Table 143). Unidentified dolphins have been used for apportioning to species level where possible.

**Table 141 Raw counts, unapportioned abundance and density estimates (mammals per km$^2$) of dolphin species in Caledonia OWF, Caledonia OWF plus 2 km buffer and the Survey Area during the May 2021 to April 2023 survey period**

| Survey | Raw count | Total unapportioned | | | | |
|---|---|---|---|---|---|---|
| | | Abundance | LCL | UCL | Precision (CV) | Density (km$^2$) |
| **a) Caledonia OWF** | | | | | | |
| **Jun-21** | 1 | 6 | 1 | 18 | 1.00 | 0.01 |
| **Jan-22** | 2 | 12 | 2 | 35 | 0.71 | 0.03 |
| **b) Caledonia OWF plus 2 km buffer** | | | | | | |
| **Jun-21** | 1 | 6 | 1 | 17 | 1.00 | 0.01 |
| **Jan-22** | 2 | 11 | 2 | 34 | 0.71 | 0.02 |
| **c) Survey Area** | | | | | | |
| **Jun-21** | 1 | 6 | 1 | 18 | 1.00 | 0.01 |
| **Jan-22** | 2 | 12 | 2 | 35 | 0.71 | 0.01 |

**Table 142 Raw counts, unapportioned abundance and density estimates (mammals per km$^2$) of dolphin species in Caledonia North, Caledonia North plus 2 km buffer and Caledonia North Survey Area during the May 2021 to April 2023 survey period**

| Survey | Raw count | Total unapportioned | | | | |
|---|---|---|---|---|---|---|
| | | Abundance | LCL | UCL | Precision (CV) | Density (km$^2$) |
| **a) Caledonia North** | | | | | | |
| **Jun-21** | 1 | 6 | 1 | 18 | 1.00 | 0.03 |
| **b) Caledonia North plus 2 km buffer** | | | | | | |
| **Jun-21** | 1 | 6 | 1 | 17 | 1.00 | 0.02 |
| **c) Caledonia North Survey Area** | | | | | | |
| **Jun-21** | 1 | 6 | 1 | 18 | 1.00 | 0.01 |

**Table 143 Raw counts, unapportioned abundance and density estimates (mammals per km$^2$) of dolphin species in Caledonia South, Caledonia South plus 2 km buffer and Caledonia South Survey Area during the May 2021 to April 2023 survey period**

| Survey | Raw count | Total unapportioned | | | | |
|---|---|---|---|---|---|---|
| | | Abundance | LCL | UCL | Precision (CV) | Density (km$^2$) |
| **a) Caledonia South** | | | | | | |
| **Jan-22** | 2 | 12 | 2 | 35 | 0.71 | 0.06 |
| **b) Caledonia South plus 2 km buffer** | | | | | | |
| **Jun-21** | 1 | 6 | 1 | 17 | 1.00 | 0.02 |
| **Jan-22** | 2 | 11 | 2 | 34 | 0.71 | 0.03 |
| **c) Caledonia South Survey Area** | | | | | | |
| **Jun-21** | 1 | 6 | 1 | 17 | 1.00 | 0.01 |
| **Jan-22** | 2 | 12 | 2 | 35 | 0.71 | 0.02 |

### *ii. Distribution and behaviour*

Unidentified dolphins were recorded in the southern part of Caledonia North in June 2021 (Appendix 4, Figure A4.347) and in the east of Caledonia South in January 2022 (Appendix 4, Figure A4.348).

### 4.45 Harbour porpoise

#### *i. Abundance and density estimates*

A total of 141 harbour porpoises were recorded in the Survey Area during both years of baseline surveys (Table 11). Harbour porpoises were recorded throughout the year, except in August and November 2021, January and October 2022 (Table 11, Table 144). They were most abundant in October 2021 in Caledonia OWF, in July 2022 in Caledonia plus 2 km buffer and in June 2022 in the Survey area (Table 144):

- 12 individuals were recorded in Caledonia OWF in October 2021, resulting in an unapportioned mean abundance estimate of 70 [12; 158], an apportioned mean abundance estimate of 110 [21; 268] and an apportioned and availability bias-corrected mean abundance estimate of 242 [46; 589] individuals. These equated to mean density estimates of 0.16 (unapportioned), 0.26 (apportioned) and 0.57 (apportioned and availability bias-corrected) mammals/km$^2$.
- 15 individuals were recorded in Caledonia OWF plus 2 km buffer in July 2022, resulting in an unapportioned mean abundance estimate of 86 [23; 173], an apportioned mean abundance estimate of 87 [18; 190] and an apportioned and availability bias-corrected mean abundance estimate of 159 [33; 347] individuals. These equated to mean density estimates of 0.13 (unapportioned), 0.14 (apportioned) and 0.25 (apportioned and availability bias-corrected) mammals/km$^2$.
- 22 individuals were recorded in the Survey Area in June 2022, resulting in an unapportioned mean abundance estimate of 127 [75; 185], an apportioned mean abundance estimate of 160 [61; 278] and an apportioned and availability bias-corrected mean abundance estimate of 293 [111; 508] individuals. These equated to mean density estimates of 0.14 (unapportioned), 0.18 (apportioned) and 0.33 (apportioned and availability bias-corrected) mammals/km$^2$.

Measures of precisions were high (indicating lower levels of precision), which is likely related to the low numbers of individuals recorded in each reporting region during each survey (CV > 0.16, Table 144).

**Table 144 Raw counts, unapportioned, apportioned, and apportioned and availability bias-corrected abundance and density estimates (mammals per km$^2$) of harbour porpoises in Caledonia OWF, Caledonia OWF plus 2 km buffer and the Survey Area during the May 2021 to April 2023 survey period**

| Survey | Raw count | Total unapportioned | | | | | Total apportioned | | | | Total apportioned and bias-corrected | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Abundance | LCL | UCL | Precision (CV) | Density (km$^2$) | Abundance | LCL | UCL | Density (km$^2$) | Abundance | LCL | UCL | Density (km$^2$) |
| **a) Caledonia OWF** | | | | | | | | | | | | | | |
| **May-21** | 1 | 6 | 1 | 17 | 1.00 | 0.01 | 23 | 4 | 69 | 0.05 | 40 | 7 | 121 | 0.09 |
| **Jun-21** | 2 | 12 | 2 | 29 | 0.71 | 0.03 | 18 | 3 | 41 | 0.04 | 33 | 5 | 75 | 0.08 |
| **Jul-21** | 0 | - | - | - | - | - | 6 | 1 | 18 | 0.01 | 11 | 2 | 33 | 0.03 |
| **Sep-21** | 1 | 6 | 1 | 17 | 1.00 | 0.01 | 12 | 2 | 34 | 0.03 | 26 | 4 | 75 | 0.06 |
| **Oct-21** | 12 | 70 | 12 | 158 | 0.29 | 0.16 | 110 | 21 | 268 | 0.26 | 242 | 46 | 589 | 0.57 |
| **Dec-21** | 1 | 6 | 1 | 17 | 1.00 | 0.01 | 6 | 1 | 17 | 0.01 | 13 | 2 | 36 | 0.03 |
| **Mar-22** | 6 | 32 | 6 | 70 | 0.41 | 0.07 | 43 | 8 | 97 | 0.1 | 75 | 14 | 170 | 0.18 |
| **Apr-22** | 5 | 29 | 5 | 58 | 0.45 | 0.07 | 29 | 5 | 75 | 0.07 | 51 | 9 | 131 | 0.12 |
| **May-22** | 5 | 29 | 6 | 52 | 0.45 | 0.07 | 33 | 7 | 62 | 0.08 | 58 | 12 | 109 | 0.14 |
| **Jun-22** | 7 | 40 | 11 | 80 | 0.38 | 0.09 | 68 | 14 | 133 | 0.16 | 124 | 25 | 243 | 0.29 |
| **Jul-22** | 10 | 58 | 12 | 111 | 0.32 | 0.14 | 59 | 13 | 117 | 0.14 | 108 | 24 | 214 | 0.25 |
| **Aug-22** | 4 | 23 | 4 | 52 | 0.50 | 0.05 | 23 | 4 | 46 | 0.05 | 42 | 7 | 84 | 0.1 |
| **Sep-22** | 7 | 41 | 12 | 69 | 0.38 | 0.1 | 40 | 7 | 99 | 0.09 | 88 | 15 | 218 | 0.21 |
| **Nov-22** | 1 | 6 | 1 | 18 | 1.00 | 0.01 | 6 | 1 | 18 | 0.01 | 13 | 2 | 40 | 0.03 |
| **Jan-23** | 2 | 12 | 2 | 29 | 0.71 | 0.03 | 12 | 2 | 29 | 0.03 | 25 | 4 | 61 | 0.06 |
| **Feb-23** | 4 | 23 | 4 | 57 | 0.50 | 0.05 | 23 | 4 | 57 | 0.05 | 49 | 8 | 121 | 0.11 |
| **Mar-23** | 3 | 18 | 3 | 35 | 0.58 | 0.04 | 18 | 3 | 47 | 0.04 | 32 | 5 | 82 | 0.07 |
| **Apr-23** | 1 | 6 | 1 | 17 | 1.00 | 0.01 | 12 | 2 | 34 | 0.03 | 21 | 4 | 60 | 0.05 |
| **b) Caledonia OWF plus 2 km buffer** | | | | | | | | | | | | | | |
| **May-21** | 3 | 17 | 3 | 46 | 0.58 | 0.03 | 34 | 6 | 98 | 0.05 | 60 | 11 | 172 | 0.09 |
| **Jun-21** | 2 | 12 | 2 | 23 | 0.71 | 0.02 | 12 | 3 | 46 | 0.02 | 33 | 5 | 84 | 0.05 |
| **Jul-21** | 1 | 6 | 1 | 17 | 1.00 | 0.01 | 6 | 3 | 46 | 0.01 | 33 | 5 | 84 | 0.05 |
| **Aug-21** | 0 | - | - | - | - | - | 2 | 0 | 6 | - | 4 | 1 | 11 | 0.01 |
| **Sep-21** | 1 | 6 | 1 | 17 | 1.00 | 0.01 | 17 | 3 | 46 | 0.03 | 37 | 7 | 101 | 0.06 |
| **Oct-21** | 12 | 69 | 12 | 156 | 0.29 | 0.11 | 108 | 21 | 277 | 0.17 | 238 | 46 | 609 | 0.37 |
| **Dec-21** | 4 | 23 | 4 | 52 | 0.50 | 0.04 | 23 | 4 | 57 | 0.04 | 49 | 8 | 121 | 0.08 |
| **Jan-22** | 0 | - | - | - | - | - | - | 1 | 9 | - | 13 | 1 | 18 | 0.02 |
| **Feb-22** | 1 | 5 | 1 | 16 | 1.00 | 0.01 | 5 | 1 | 16 | 0.01 | 11 | 2 | 34 | 0.02 |

| Survey | Raw count | Total unapportioned | | | | | Total apportioned | | | | Total apportioned and bias-corrected | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Abundance | LCL | UCL | Precision (CV) | Density (km$^2$) | Abundance | LCL | UCL | Density (km$^2$) | Abundance | LCL | UCL | Density (km$^2$) |
| **Mar-22** | 7 | 37 | 7 | 74 | 0.38 | 0.06 | 48 | 9 | 107 | 0.07 | 84 | 16 | 187 | 0.13 |
| **Apr-22** | 6 | 34 | 11 | 62 | 0.41 | 0.05 | 34 | 6 | 90 | 0.05 | 60 | 11 | 158 | 0.09 |
| **May-22** | 9 | 51 | 23 | 92 | 0.33 | 0.08 | 56 | 14 | 109 | 0.09 | 98 | 24 | 192 | 0.15 |
| **Jun-22** | 14 | 80 | 40 | 120 | 0.27 | 0.12 | 108 | 32 | 203 | 0.17 | 198 | 58 | 371 | 0.31 |
| **Jul-22** | 15 | 86 | 23 | 173 | 0.26 | 0.13 | 87 | 18 | 190 | 0.14 | 159 | 33 | 347 | 0.25 |
| **Aug-22** | 8 | 46 | 17 | 74 | 0.35 | 0.07 | 46 | 23 | 74 | 0.07 | 84 | 42 | 135 | 0.13 |
| **Sep-22** | 7 | 40 | 12 | 75 | 0.38 | 0.06 | 40 | 7 | 104 | 0.06 | 88 | 15 | 229 | 0.14 |
| **Nov-22** | 3 | 17 | 3 | 35 | 0.58 | 0.03 | 18 | 3 | 46 | 0.03 | 40 | 7 | 101 | 0.06 |
| **Dec-22** | 0 | - | - | - | - | - | 3 | 1 | 8 | 0.01 | 7 | 1 | 17 | 0.01 |
| **Jan-23** | 3 | 17 | 6 | 35 | 0.58 | 0.03 | 17 | 6 | 35 | 0.03 | 36 | 13 | 74 | 0.06 |
| **Feb-23** | 7 | 40 | 7 | 86 | 0.38 | 0.06 | 40 | 7 | 86 | 0.06 | 85 | 15 | 182 | 0.13 |
| **Mar-23** | 7 | 41 | 12 | 75 | 0.38 | 0.06 | 40 | 7 | 99 | 0.06 | 70 | 12 | 173 | 0.11 |
| **Apr-23** | 3 | 17 | 3 | 40 | 0.58 | 0.03 | 28 | 5 | 68 | 0.04 | 49 | 9 | 119 | 0.08 |
| **c) Survey Area** | | | | | | | | | | | | | | |
| **May-21** | 3 | 18 | 3 | 47 | 0.58 | 0.02 | 41 | 7 | 117 | 0.05 | 72 | 12 | 205 | 0.08 |
| **Jun-21** | 2 | 12 | 2 | 29 | 0.71 | 0.01 | 18 | 3 | 47 | 0.02 | 33 | 5 | 86 | 0.04 |
| **Jul-21** | 2 | 12 | 2 | 30 | 0.71 | 0.01 | 30 | 5 | 66 | 0.03 | 55 | 9 | 121 | 0.06 |
| **Aug-21** | 0 | - | - | - | - | - | 3 | 1 | 9 | 0.00 | 5 | 1 | 16 | 0.01 |
| **Sep-21** | 3 | 18 | 3 | 35 | 0.58 | 0.02 | 22 | 4 | 57 | 0.02 | 48 | 8 | 125 | 0.05 |
| **Oct-21** | 12 | 70 | 12 | 158 | 0.29 | 0.08 | 110 | 19 | 275 | 0.12 | 242 | 41 | 605 | 0.27 |
| **Dec-21** | 4 | 23 | 4 | 52 | 0.50 | 0.03 | 23 | 4 | 64 | 0.03 | 49 | 8 | 136 | 0.06 |
| **Feb-22** | 2 | 11 | 2 | 27 | 0.71 | 0.01 | 11 | 2 | 37 | 0.01 | 24 | 5 | 78 | 0.03 |
| **Mar-22** | 8 | 43 | 16 | 86 | 0.35 | 0.05 | 54 | 14 | 113 | 0.06 | 95 | 25 | 198 | 0.11 |
| **Apr-22** | 6 | 35 | 6 | 69 | 0.41 | 0.04 | 34 | 6 | 92 | 0.04 | 60 | 11 | 161 | 0.07 |
| **May-22** | 10 | 58 | 17 | 105 | 0.32 | 0.07 | 63 | 16 | 133 | 0.07 | 110 | 28 | 232 | 0.12 |
| **Jun-22** | 22 | 127 | 75 | 185 | 0.21 | 0.14 | 160 | 61 | 278 | 0.18 | 293 | 111 | 508 | 0.33 |
| **Jul-22** | 19 | 111 | 47 | 193 | 0.23 | 0.13 | 111 | 36 | 205 | 0.13 | 203 | 66 | 375 | 0.23 |
| **Aug-22** | 8 | 46 | 17 | 75 | 0.35 | 0.05 | 46 | 17 | 75 | 0.05 | 84 | 31 | 137 | 0.1 |
| **Sep-22** | 9 | 53 | 12 | 93 | 0.33 | 0.06 | 52 | 9 | 117 | 0.06 | 114 | 20 | 257 | 0.13 |
| **Nov-22** | 4 | 24 | 6 | 41 | 0.50 | 0.03 | 24 | 4 | 58 | 0.03 | 53 | 9 | 127 | 0.06 |
| **Dec-22** | 1 | 6 | 1 | 18 | 1.00 | 0.01 | 6 | 1 | 18 | 0.01 | 13 | 2 | 38 | 0.01 |
| **Jan-23** | 3 | 18 | 6 | 35 | 0.58 | 0.02 | 18 | 3 | 35 | 0.02 | 38 | 6 | 74 | 0.04 |
| **Feb-23** | 9 | 52 | 12 | 93 | 0.33 | 0.06 | 52 | 12 | 98 | 0.06 | 110 | 25 | 208 | 0.12 |

| Survey | Raw count | Total unapportioned | | | | | Total apportioned | | | | Total apportioned and bias-corrected | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Abundance | LCL | UCL | Precision (CV) | Density ($km^2$) | Abundance | LCL | UCL | Density ($km^2$) | Abundance | LCL | UCL | Density ($km^2$) |
| **Mar-23** | 10 | 59 | 23 | 112 | 0.32 | 0.07 | 58 | 10 | 140 | 0.07 | 102 | 18 | 245 | 0.11 |
| **Apr-23** | 4 | 23 | 4 | 52 | 0.50 | 0.03 | 40 | 7 | 80 | 0.05 | 70 | 12 | 140 | 0.08 |

A total of 75 harbour porpoises were recorded in Caledonia North Survey Area and 102 in Caledonia South Survey Area during both years of baseline surveys (Table 12, Table 13). Harbour porpoises were mostly recorded low numbers (≤8) in Caledonia North and Caledonia South plus 2 km buffer. In Caledonia North Survey Area, peak numbers reached 14 individuals in July 2022 (Table 145). This resulted in an unapportioned and apportioned mean abundance estimates of 82 [23; 164-170] and an apportioned and availability bias-corrected mean abundance estimate of 150 [42; 311] individuals (Table 145). These equated to mean density estimates of 0.15 (unapportioned), 0.15 (apportioned) and 0.27 (apportioned and availability bias-corrected) mammals/km$^2$ (Table 145).

Similarly, harbour porpoises were mostly recorded low numbers (≤10) in Caledonia South and Caledonia plus 2 km buffer while they were recorded in higher number in Caledonia South Survey Area, where peak numbers reached 14 individuals in June and July 2022 (Table 146). In June 2022, this resulted in an estimated unapportioned mean abundance of 81 [41; 116], an apportioned mean abundance of 103 [41; 197] and an apportioned and availability bias-corrected mean abundance of 188 [75; 360] individuals (Table 146). These equated to mean density estimates of 0.15 (unapportioned), 0.19 (apportioned) and 0.35 (apportioned and availability bias-corrected) mammals/km$^2$ (Table 146). In July 2022, the peak of 14 individuals resulted in an estimated unapportioned mean abundance estimate of 81 [35; 127], an apportioned mean abundance estimate of 81 [30; 139] and an apportioned and availability bias-corrected mean abundance estimate of 148 [55; 254] individuals (Table 146). These equated to mean density estimates of 0.15 (unapportioned), 0.15 (apportioned) and 0.28 (apportioned and availability bias-corrected) mammals/km$^2$ (Table 146).

Measures of precisions were high (indicating lower levels of precision), which is likely related to the low numbers of individuals recorded in each reporting region during each survey (CV > 0.16, Table 145 and Table 146).

**Table 145 Raw counts, unapportioned, apportioned, and apportioned and availability bias-corrected abundance and density estimates (mammals per km$^2$) of harbour porpoises in Caledonia North, Caledonia North plus 2 km buffer and Caledonia North Survey Area during the May 2021 to April 2023 survey period**

| Survey | Raw count | Total unapportioned | | | | | Total apportioned | | | | Total apportioned and bias-corrected | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Abundance | LCL | UCL | Precision (CV) | Density (km$^2$) | Abundance | LCL | UCL | Density (km$^2$) | Abundance | LCL | UCL | Density (km$^2$) |
| **a) Caledonia North** | | | | | | | | | | | | | | |
| **May-21** | 1 | 6 | 1 | 17 | 1.00 | 0.03 | 6 | 1 | 17 | 0.03 | 11 | 2 | 30 | 0.02 |
| **Jun-21** | 2 | 12 | 2 | 30 | 0.71 | 0.05 | 12 | 2 | 30 | 0.05 | 22 | 4 | 55 | 0.04 |
| **Aug-21** | 0 | - | - | - | - | - | 6 | 1 | 17 | 0.03 | 11 | 2 | 31 | 0.02 |
| **Sep-21** | 1 | 6 | 1 | 17 | 1.00 | 0.03 | 6 | 1 | 17 | 0.03 | 13 | 2 | 37 | 0.02 |
| **Oct-21** | 3 | 18 | 3 | 53 | 0.58 | 0.08 | 42 | 7 | 123 | 0.19 | 91 | 15 | 270 | 0.16 |
| **Mar-22** | 3 | 16 | 3 | 37 | 0.58 | 0.07 | 16 | 3 | 37 | 0.07 | 28 | 5 | 65 | 0.05 |
| **Apr-22** | 4 | 23 | 6 | 46 | 0.50 | 0.11 | 23 | 4 | 57 | 0.11 | 40 | 7 | 100 | 0.07 |
| **May-22** | 2 | 12 | 2 | 23 | 0.71 | 0.05 | 12 | 2 | 23 | 0.05 | 21 | 4 | 40 | 0.04 |
| **Jun-22** | 1 | 6 | 1 | 17 | 1.00 | 0.03 | 18 | 3 | 51 | 0.08 | 33 | 5 | 93 | 0.06 |
| **Jul-22** | 5 | 29 | 5 | 76 | 0.45 | 0.13 | 29 | 5 | 76 | 0.13 | 53 | 9 | 139 | 0.1 |
| **Aug-22** | 1 | 6 | 1 | 17 | 1.00 | 0.03 | 6 | 1 | 17 | 0.03 | 11 | 2 | 31 | 0.02 |
| **Sep-22** | 3 | 17 | 3 | 40 | 0.58 | 0.08 | 17 | 3 | 51 | 0.08 | 37 | 7 | 112 | 0.07 |
| **Nov-22** | 1 | 6 | 1 | 18 | 1.00 | 0.03 | 6 | 1 | 18 | 0.03 | 13 | 2 | 40 | 0.02 |
| **Jan-23** | 1 | 6 | 1 | 17 | 1.00 | 0.03 | 6 | 1 | 17 | 0.03 | 13 | 2 | 36 | 0.02 |
| **Mar-23** | 1 | 6 | 1 | 18 | 1.00 | 0.03 | 6 | 1 | 18 | 0.03 | 11 | 2 | 32 | 0.02 |
| **Apr-23** | 2 | 11 | 2 | 23 | 0.71 | 0.05 | 11 | 2 | 23 | 0.05 | 19 | 4 | 40 | 0.03 |
| **b) Caledonia North plus 2 km buffer** | | | | | | | | | | | | | | |
| **May-21** | 1 | 6 | 1 | 17 | 1.00 | 0.02 | 6 | 1 | 17 | 0.02 | 11 | 2 | 30 | 0.03 |
| **Jun-21** | 2 | 12 | 2 | 23 | 0.71 | 0.03 | 12 | 2 | 29 | 0.03 | 22 | 4 | 53 | 0.06 |
| **Jul-21** | 0 | - | - | - | - | - | 6 | 1 | 17 | 0.02 | 11 | 2 | 31 | 0.03 |
| **Aug-21** | 0 | - | - | - | - | - | 6 | 1 | 17 | 0.02 | 11 | 2 | 31 | 0.03 |
| **Sep-21** | 1 | 6 | 1 | 17 | 1.00 | 0.02 | 17 | 3 | 45 | 0.05 | 37 | 7 | 99 | 0.10 |
| **Oct-21** | 4 | 23 | 4 | 57 | 0.50 | 0.06 | 51 | 9 | 131 | 0.14 | 112 | 19 | 288 | 0.30 |
| **Dec-21** | 1 | 6 | 1 | 17 | 1.00 | 0.02 | 6 | 1 | 17 | 0.02 | 13 | 2 | 36 | 0.03 |
| **Feb-22** | 1 | 5 | 1 | 16 | 1.00 | 0.01 | 5 | 1 | 16 | 0.01 | 11 | 2 | 34 | 0.03 |
| **Mar-22** | 3 | 16 | 3 | 37 | 0.58 | 0.04 | 21 | 4 | 59 | 0.06 | 37 | 7 | 103 | 0.10 |
| **Apr-22** | 5 | 28 | 6 | 51 | 0.45 | 0.07 | 28 | 5 | 67 | 0.07 | 49 | 9 | 117 | 0.13 |

| Survey | Raw count | Total unapportioned | | | | | Total apportioned | | | | Total apportioned and bias-corrected | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Abundance | LCL | UCL | Precision (CV) | Density ($km^2$) | Abundance | LCL | UCL | Density ($km^2$) | Abundance | LCL | UCL | Density ($km^2$) |
| **May-22** | 2 | 11 | 2 | 28 | 0.71 | 0.03 | 11 | 2 | 28 | 0.03 | 19 | 4 | 49 | 0.05 |
| **Jun-22** | 5 | 29 | 6 | 63 | 0.45 | 0.08 | 41 | 7 | 97 | 0.11 | 75 | 13 | 177 | 0.20 |
| **Jul-22** | 8 | 46 | 8 | 126 | 0.35 | 0.12 | 46 | 8 | 132 | 0.12 | 84 | 15 | 241 | 0.22 |
| **Aug-22** | 2 | 11 | 2 | 29 | 0.71 | 0.03 | 11 | 2 | 29 | 0.03 | 20 | 4 | 53 | 0.05 |
| **Sep-22** | 3 | 17 | 3 | 41 | 0.58 | 0.05 | 18 | 3 | 52 | 0.05 | 40 | 7 | 114 | 0.11 |
| **Nov-22** | 3 | 17 | 6 | 35 | 0.58 | 0.05 | 18 | 3 | 46 | 0.05 | 40 | 7 | 101 | 0.11 |
| **Jan-23** | 2 | 12 | 2 | 29 | 0.71 | 0.03 | 12 | 2 | 23 | 0.03 | 25 | 4 | 49 | 0.07 |
| **Mar-23** | 3 | 17 | 3 | 41 | 0.58 | 0.05 | 18 | 3 | 52 | 0.05 | 32 | 5 | 91 | 0.08 |
| **Apr-23** | 3 | 17 | 6 | 34 | 0.58 | 0.05 | 23 | 7 | 51 | 0.06 | 40 | 12 | 89 | 0.11 |
| **c) Caledonia North Survey Area** | | | | | | | | | | | | | | |
| **May-21** | 1 | 6 | 1 | 18 | 1.00 | 0.01 | 12 | 2 | 36 | 0.02 | 21 | 4 | 63 | 0.04 |
| **Jun-21** | 2 | 12 | 2 | 30 | 0.71 | 0.02 | 12 | 2 | 30 | 0.02 | 22 | 4 | 55 | 0.04 |
| **Jul-21** | 0 | - | - | - | - | - | 12 | 2 | 30 | 0.02 | 22 | 4 | 55 | 0.04 |
| **Aug-21** | 0 | - | - | - | - | - | 6 | 1 | 17 | 0.01 | 11 | 2 | 31 | 0.02 |
| **Sep-21** | 3 | 18 | 3 | 35 | 0.58 | 0.03 | 30 | 5 | 76 | 0.05 | 66 | 11 | 167 | 0.12 |
| **Oct-21** | 11 | 64 | 11 | 152 | 0.30 | 0.11 | 103 | 18 | 274 | 0.19 | 227 | 39 | 602 | 0.41 |
| **Dec-21** | 1 | 6 | 1 | 17 | 1.00 | 0.01 | 6 | 1 | 17 | 0.01 | 13 | 2 | 36 | 0.02 |
| **Feb-22** | 2 | 11 | 2 | 28 | 0.71 | 0.02 | 13 | 2 | 39 | 0.02 | 29 | 5 | 83 | 0.05 |
| **Mar-22** | 4 | 22 | 4 | 43 | 0.50 | 0.04 | 27 | 5 | 65 | 0.05 | 47 | 9 | 114 | 0.08 |
| **Apr-22** | 5 | 29 | 6 | 52 | 0.45 | 0.05 | 29 | 5 | 75 | 0.05 | 51 | 9 | 131 | 0.09 |
| **May-22** | 2 | 12 | 2 | 29 | 0.71 | 0.02 | 12 | 2 | 29 | 0.02 | 21 | 4 | 51 | 0.04 |
| **Jun-22** | 9 | 52 | 17 | 87 | 0.33 | 0.09 | 69 | 16 | 145 | 0.12 | 125 | 29 | 266 | 0.22 |
| **Jul-22** | 14 | 82 | 23 | 164 | 0.27 | 0.15 | 82 | 23 | 170 | 0.15 | 150 | 42 | 311 | 0.27 |
| **Aug-22** | 3 | 17 | 3 | 34 | 0.58 | 0.03 | 17 | 3 | 34 | 0.03 | 31 | 5 | 62 | 0.06 |
| **Sep-22** | 6 | 35 | 6 | 64 | 0.41 | 0.06 | 35 | 6 | 81 | 0.06 | 77 | 13 | 178 | 0.14 |
| **Nov-22** | 3 | 18 | 3 | 35 | 0.58 | 0.03 | 18 | 3 | 47 | 0.03 | 40 | 7 | 103 | 0.07 |
| **Jan-23** | 2 | 12 | 2 | 29 | 0.71 | 0.02 | 12 | 2 | 29 | 0.02 | 25 | 4 | 61 | 0.05 |
| **Mar-23** | 4 | 23 | 4 | 59 | 0.50 | 0.04 | 24 | 4 | 71 | 0.04 | 42 | 7 | 124 | 0.08 |
| **Apr-23** | 3 | 17 | 3 | 34 | 0.58 | 0.03 | 23 | 7 | 51 | 0.04 | 40 | 12 | 89 | 0.07 |

**Table 146** **Raw counts, unapportioned, apportioned, and apportioned and availability bias-corrected abundance and density estimates (mammals per km$^2$) of harbour porpoises in Caledonia South, Caledonia South plus 2 km buffer and Caledonia South Survey Area during the May 2021 to April 2023 survey period**

| Survey | Raw count | Total unapportioned | | | | | Total apportioned | | | | Total apportioned and bias-corrected | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Abundance | LCL | UCL | Precision (CV) | Density (km$^2$) | Abundance | LCL | UCL | Density (km$^2$) | Abundance | LCL | UCL | Density (km$^2$) |
| **a) Caledonia South** | | | | | | | | | | | | | | |
| **May-21** | 0 | - | - | - | - | - | 17 | 3 | 52 | 0.08 | 30 | 5 | 91 | 0.14 |
| **Jun-21** | 0 | - | - | - | - | - | 6 | 1 | 17 | 0.03 | 11 | 2 | 31 | 0.05 |
| **Jul-21** | 0 | - | - | - | - | - | 6 | 1 | 18 | 0.03 | 11 | 2 | 33 | 0.05 |
| **Sep-21** | 0 | - | - | - | - | - | 6 | 1 | 17 | 0.03 | 13 | 2 | 37 | 0.06 |
| **Oct-21** | 9 | 53 | 9 | 135 | 0.33 | 0.25 | 53 | 9 | 141 | 0.25 | 116 | 20 | 310 | 0.55 |
| **Dec-21** | 1 | 6 | 1 | 17 | 1.00 | 0.03 | 6 | 1 | 17 | 0.03 | 13 | 2 | 36 | 0.06 |
| **Mar-22** | 3 | 16 | 3 | 38 | 0.58 | 0.08 | 27 | 5 | 70 | 0.13 | 47 | 9 | 123 | 0.22 |
| **Apr-22** | 1 | 6 | 1 | 17 | 1.00 | 0.03 | 6 | 1 | 17 | 0.03 | 11 | 2 | 30 | 0.05 |
| **May-22** | 3 | 17 | 6 | 35 | 0.58 | 0.08 | 23 | 4 | 52 | 0.11 | 40 | 7 | 91 | 0.19 |
| **Jun-22** | 6 | 35 | 6 | 75 | 0.41 | 0.17 | 52 | 9 | 116 | 0.25 | 95 | 16 | 212 | 0.45 |
| **Jul-22** | 5 | 29 | 5 | 64 | 0.45 | 0.14 | 29 | 5 | 75 | 0.14 | 53 | 9 | 137 | 0.25 |
| **Aug-22** | 3 | 17 | 3 | 40 | 0.58 | 0.08 | 17 | 3 | 46 | 0.08 | 31 | 5 | 84 | 0.15 |
| **Sep-22** | 4 | 23 | 4 | 47 | 0.50 | 0.11 | 23 | 4 | 58 | 0.11 | 51 | 9 | 127 | 0.24 |
| **Oct-22** | - | - | - | - | - | - | 2 | - | 6 | 0.01 | 5 | 1 | 13 | 0.02 |
| **Jan-23** | 1 | 6 | 1 | 18 | 1.00 | 0.03 | 6 | 1 | 18 | 0.03 | 13 | 2 | 38 | 0.06 |
| **Feb-23** | 4 | 23 | 4 | 63 | 0.50 | 0.11 | 23 | 4 | 57 | 0.11 | 49 | 8 | 121 | 0.23 |
| **Mar-23** | 2 | 12 | 2 | 29 | 0.71 | 0.06 | 12 | 2 | 29 | 0.06 | 21 | 4 | 51 | 0.1 |
| **Apr-23** | - | - | - | - | - | - | 6 | 1 | 17 | 0.03 | 11 | 2 | 30 | 0.05 |
| **b) Caledonia South plus 2 km buffer** | | | | | | | | | | | | | | |
| **May-21** | 2 | 12 | 2 | 29 | 0.71 | 0.03 | 29 | 19 | 86 | 0.08 | 51 | 33 | 151 | 0.14 |
| **Jun-21** | 1 | 6 | 1 | 17 | 1.00 | 0.02 | 12 | 7 | 34 | 0.03 | 22 | 13 | 62 | 0.06 |
| **Jul-21** | 1 | 6 | 1 | 17 | 1.00 | 0.02 | 12 | 7 | 34 | 0.03 | 22 | 13 | 62 | 0.06 |
| **Sep-22** | 0 | - | - | - | - | - | 3 | 3 | 7 | 0.01 | 6 | 6 | 15 | 0.02 |
| **Oct-21** | 10 | 58 | 10 | 139 | 0.32 | 0.16 | 58 | 10 | 145 | 0.16 | 127 | 22 | 319 | 0.35 |
| **Dec-21** | 4 | 23 | 6 | 46 | 0.50 | 0.06 | 23 | 4 | 63 | 0.06 | 49 | 8 | 133 | 0.14 |
| **Mar-22** | 4 | 21 | 5 | 48 | 0.50 | 0.06 | 32 | 15 | 74 | 0.09 | 56 | 26 | 130 | 0.16 |
| **Apr-22** | 2 | 11 | 2 | 34 | 0.71 | 0.03 | 11 | 2 | 34 | 0.03 | 19 | 4 | 60 | 0.05 |

| Survey | Raw count | Total unapportioned | | | | | Total apportioned | | | | Total apportioned and bias-corrected | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Abundance | LCL | UCL | Precision (CV) | Density ($km^2$) | Abundance | LCL | UCL | Density ($km^2$) | Abundance | LCL | UCL | Density ($km^2$) |
| **May-22** | 7 | 40 | 17 | 63 | 0.38 | 0.11 | 46 | 19 | 92 | 0.13 | 81 | 33 | 161 | 0.22 |
| **Jun-22** | 10 | 57 | 23 | 91 | 0.32 | 0.16 | 73 | 30 | 153 | 0.20 | 133 | 55 | 280 | 0.37 |
| **Jul-22** | 9 | 52 | 17 | 98 | 0.33 | 0.14 | 52 | 13 | 98 | 0.14 | 95 | 24 | 179 | 0.26 |
| **Aug-22** | 7 | 40 | 11 | 69 | 0.38 | 0.11 | 40 | 11 | 69 | 0.11 | 73 | 20 | 126 | 0.2 |
| **Sep-22** | 5 | 29 | 5 | 63 | 0.45 | 0.08 | 29 | 5 | 74 | 0.08 | 64 | 11 | 163 | 0.18 |
| **Nov-22** | 1 | 6 | 1 | 17 | 1.00 | 0.02 | 6 | 1 | 17 | 0.02 | 13 | 2 | 37 | 0.04 |
| **Dec-22** | 0 | - | - | - | - | - | 6 | 6 | 17 | 0.02 | 13 | 13 | 36 | 0.04 |
| **Jan-23** | 1 | 6 | 1 | 17 | 1.00 | 0.02 | 6 | 1 | 17 | 0.02 | 13 | 2 | 36 | 0.04 |
| **Feb-23** | 7 | 40 | 7 | 86 | 0.38 | 0.11 | 40 | 7 | 86 | 0.11 | 85 | 15 | 182 | 0.24 |
| **Mar-23** | 4 | 23 | 6 | 40 | 0.50 | 0.06 | 24 | 4 | 52 | 0.07 | 42 | 7 | 91 | 0.12 |
| **Apr-23** | 1 | 6 | 1 | 17 | 1.00 | 0.02 | 12 | 7 | 34 | 0.03 | 21 | 12 | 60 | 0.06 |
| **c) Caledonia South Survey Area** | | | | | | | | | | | | | | |
| **May-21** | 3 | 17 | 3 | 46 | 0.58 | 0.03 | 35 | 6 | 98 | 0.07 | 61 | 11 | 172 | 0.11 |
| **Jun-21** | 1 | 6 | 1 | 17 | 1.00 | 0.01 | 12 | 2 | 34 | 0.02 | 22 | 4 | 62 | 0.04 |
| **Jul-21** | 2 | 12 | 2 | 30 | 0.71 | 0.02 | 18 | 3 | 48 | 0.03 | 33 | 5 | 88 | 0.06 |
| **Sep-21** | 1 | 6 | 1 | 17 | 1.00 | 0.01 | 6 | 1 | 17 | 0.01 | 13 | 2 | 37 | 0.02 |
| **Oct-21** | 10 | 58 | 10 | 145 | 0.32 | 0.11 | 104 | 18 | 284 | 0.19 | 229 | 40 | 624 | 0.43 |
| **Dec-21** | 4 | 23 | 4 | 46 | 0.50 | 0.04 | 23 | 4 | 63 | 0.04 | 49 | 8 | 133 | 0.09 |
| **Mar-22** | 5 | 27 | 5 | 54 | 0.45 | 0.05 | 37 | 8 | 81 | 0.07 | 65 | 14 | 142 | 0.12 |
| **Apr-22** | 3 | 17 | 3 | 46 | 0.58 | 0.03 | 17 | 3 | 51 | 0.03 | 30 | 5 | 89 | 0.06 |
| **May-22** | 9 | 52 | 17 | 103 | 0.33 | 0.10 | 57 | 15 | 120 | 0.11 | 100 | 26 | 210 | 0.19 |
| **Jun-22** | 14 | 81 | 41 | 116 | 0.27 | 0.15 | 103 | 41 | 197 | 0.19 | 188 | 75 | 360 | 0.35 |
| **Jul-22** | 14 | 81 | 35 | 127 | 0.27 | 0.15 | 81 | 30 | 139 | 0.15 | 148 | 55 | 254 | 0.28 |
| **Aug-22** | 7 | 40 | 11 | 69 | 0.38 | 0.07 | 40 | 11 | 69 | 0.07 | 73 | 20 | 126 | 0.14 |
| **Sep-22** | 5 | 29 | 5 | 58 | 0.45 | 0.05 | 29 | 5 | 76 | 0.05 | 64 | 11 | 167 | 0.12 |
| **Nov-22** | 2 | 12 | 2 | 29 | 0.71 | 0.02 | 12 | 2 | 36 | 0.02 | 26 | 4 | 79 | 0.05 |
| **Dec-22** | 1 | 6 | 1 | 18 | 1.00 | 0.01 | 12 | 2 | 36 | 0.02 | 25 | 4 | 76 | 0.05 |
| **Jan-23** | 2 | 12 | 2 | 29 | 0.71 | 0.02 | 12 | 2 | 29 | 0.02 | 25 | 4 | 61 | 0.05 |
| **Feb-23** | 9 | 52 | 12 | 92 | 0.33 | 0.10 | 52 | 12 | 98 | 0.10 | 110 | 25 | 208 | 0.21 |
| **Mar-23** | 0 | - | - | - | - | - | 46 | 8 | 111 | 0.09 | 81 | 14 | 194 | 0.15 |
| **Apr-23** | 0 | - | - | - | - | - | 22 | 4 | 58 | 0.04 | 39 | 7 | 102 | 0.07 |

### *ii. Distribution and behaviour*

Maps of distribution are shown in Appendix 4: Figures A4.349-368. Harbour porpoises overall did not show any specific distributional pattern and were scattered across the Survey Area. They were recorded in central and eastern parts of the Survey Area during May 2021 and November 2022 (Figures A4.349, 363), whereas the individuals in June and October 2021 were recorded in the central west (Figures A4.350, 353). They were recorded in the central parts of the Survey Area, in the south of Caledonia North Survey Area in September 2021 (Figures A4.352). Individuals were recorded in the south in December 2022 (Figure A4.364), and individuals in January 2023 were recorded in the central west and south (Figure A4.365). In July 2021, harbour porpoises were recorded in the southwest and northeast of Caledonia South Buffer Zone (Figure A4.351). More loose distribution was observed between December 2021 and June 2022, and in September 2022 and April 2023, with records stretching from the northwest to south and east of the Survey Area (Figures A4.354-359, 362, 368). While distribution remained scattered, most records during July and August 2022, and during February and March 2023 were in the southern half of the Survey Area (Figures A4.360-361, 366-367).

## 4.46 Unidentified dolphin and / or porpoise species

### *i. Abundance and density estimates*

A total of 39 unidentified dolphins and / or porpoises were recorded in the Survey Area during both years of baseline surveys (Table 11). Dolphins and / or porpoises were recorded in the Survey Area in every survey, except in August and December 2021, April 2022, from July to September 2022 and from November 2022 to March2023 (Table 11, Table 147). In the Survey Area, a peak of eight individuals were recorded in October 2021, resulting in an unapportioned abundance estimate of 47 [8; 140] individuals, which equated to a mean density estimate of 0.05 mammals/km$^2$ (Table 147). Unidentified dolphin and / or porpoises have been used for apportioning to species level where possible.

**Table 147 Raw counts, unapportioned abundance and density estimates (mammals per km$^2$) of unidentified dolphin and / or porpoise species in Caledonia OWF, Caledonia OWF plus 2 km buffer and the Survey Area during the May 2021 to April 2023 survey period**

| Survey | Raw count | Total unapportioned | | | | |
|---|---|---|---|---|---|---|
| | | Abundance | LCL | UCL | Precision (CV) | Density (km$^2$) |
| **a) Caledonia OWF** | | | | | | |
| **May-21** | 3 | 17 | 3 | 52 | 0.58 | 0.04 |
| **Jun-21** | 1 | 6 | 1 | 18 | <1 | 0.01 |
| **Jul-21** | 1 | 6 | 1 | 18 | <1 | 0.01 |
| **Sep-21** | 1 | 6 | 1 | 17 | <1 | 0.01 |
| **Oct-21** | 8 | 47 | 8 | 140 | 0.35 | 0.11 |
| **Nov-21** | 1 | 6 | 1 | 17 | <1 | 0.01 |
| **Jan-22** | 1 | 6 | 1 | 17 | <1 | 0.01 |
| **Feb-22** | 2 | 11 | 2 | 32 | 0.71 | 0.03 |
| **Mar-22** | 2 | 11 | 2 | 27 | 0.71 | 0.03 |
| **May-22** | 1 | 6 | 1 | 17 | <1 | 0.01 |
| **Jun-22** | 4 | 23 | 4 | 46 | 0.50 | 0.05 |
| **Oct-22** | 1 | 6 | 1 | 18 | <1 | 0.01 |
| **Apr-23** | 1 | 6 | 1 | 17 | <1 | 0.01 |
| **b) Caledonia OWF plus 2 km** | | | | | | |
| **May-21** | 3 | 17 | 3 | 52 | 0.58 | 0.03 |
| **Jun-21** | 1 | 6 | 1 | 17 | <1 | 0.01 |
| **Jul-21** | 2 | 12 | 2 | 29 | 0.71 | 0.02 |
| **Sep-21** | 2 | 11 | 2 | 29 | 0.71 | 0.02 |

| Survey | Raw count | Total unapportioned | | | | |
|---|---|---|---|---|---|---|
| | | Abundance | LCL | UCL | Precision (CV) | Density (km²) |
| **Oct-21** | 8 | 46 | 8 | 138 | 0.35 | 0.07 |
| **Nov-21** | 3 | 17 | 3 | 46 | 0.58 | 0.03 |
| **Jan-22** | 1 | 6 | 1 | 17 | <1 | 0.01 |
| **Feb-22** | 2 | 11 | 2 | 32 | 0.71 | 0.02 |
| **Mar-22** | 2 | 11 | 2 | 27 | 0.71 | 0.02 |
| **May-22** | 1 | 6 | 1 | 17 | <1 | 0.01 |
| **Jun-22** | 4 | 23 | 4 | 46 | 0.50 | 0.04 |
| **Oct-22** | 1 | 6 | 1 | 17 | <1 | 0.01 |
| **Apr-23** | 2 | 11 | 2 | 28 | 0.71 | 0.02 |
| **c) Survey Area** | | | | | | |
| **May-21** | 4 | 23 | 4 | 70 | 0.50 | 0.03 |
| **Jun-21** | 1 | 6 | 1 | 18 | <1 | 0.01 |
| **Jul-21** | 3 | 18 | 6 | 36 | 0.58 | 0.02 |
| **Sep-21** | 2 | 12 | 2 | 29 | 0.71 | 0.01 |
| **Oct-21** | 8 | 47 | 8 | 140 | 0.35 | 0.05 |
| **Nov-21** | 6 | 35 | 6 | 76 | 0.41 | 0.04 |
| **Jan-22** | 1 | 6 | 1 | 17 | <1 | 0.01 |
| **Feb-22** | 2 | 11 | 2 | 33 | 0.71 | 0.01 |
| **Mar-22** | 2 | 11 | 2 | 27 | 0.71 | 0.01 |
| **May-22** | 1 | 6 | 1 | 17 | <1 | 0.01 |
| **Jun-22** | 4 | 23 | 4 | 52 | 0.50 | 0.03 |
| **Oct-22** | 2 | 12 | 2 | 35 | 0.71 | 0.01 |
| **Apr-23** | 3 | 17 | 3 | 34 | 0.58 | 0.02 |

A total of 22 unidentified dolphins and / or porpoises were recorded in Caledonia North Survey Area, in May, July and from September to November 2021, February, March and June 2022 (Table 12). In the Caledonia North Survey Area, a peak of eight individuals were recorded in October 2021, resulting in an unapportioned abundance estimate of 47 [8; 140] individuals, which equated to a mean density estimate of 0.08 mammals/km$^2$ (Table 148).

**Table 148 Raw counts, unapportioned abundance and density estimates (mammals per km$^2$) of unidentified dolphin and / or porpoise species in Caledonia North, Caledonia North plus 2 km buffer and Caledonia North Survey Area during the May 2021 to April 2023 survey period**

| Survey | Raw count | Total unapportioned | | | | |
|---|---|---|---|---|---|---|
| | | Abundance | LCL | UCL | Precision (CV) | Density (km²) |
| **a) Caledonia North** | | | | | | |
| **Oct-21** | 8 | 47 | 8 | 140 | 0.35 | 0.22 |
| **Jun-22** | 1 | 6 | 1 | 17 | 1.00 | 0.03 |
| **b) Caledonia North plus 2 km buffer** | | | | | | |
| **Jul-21** | 1 | 6 | 1 | 17 | 1.00 | 0.02 |
| **Sep-21** | 2 | 11 | 2 | 28 | 0.71 | 0.03 |
| **Oct-21** | 8 | 46 | 8 | 137 | 0.35 | 0.12 |
| **Nov-21** | 1 | 6 | 1 | 17 | 1.00 | 0.02 |
| **Mar-22** | 1 | 5 | 1 | 16 | 1.00 | 0.01 |
| **Jun-22** | 1 | 6 | 1 | 17 | 1.00 | 0.02 |
| **Apr-23** | 1 | 6 | 1 | 17 | 1.00 | 0.02 |
| **c) Caledonia North Survey Area** | | | | | | |
| **May-21** | 1 | 6 | 1 | 18 | 1.00 | 0.01 |
| **Jul-21** | 2 | 12 | 2 | 30 | 0.71 | 0.02 |
| **Sep-21** | 2 | 12 | 2 | 29 | 0.71 | 0.02 |
| **Oct-21** | 8 | 47 | 8 | 140 | 0.35 | 0.08 |
| **Nov-21** | 4 | 23 | 4 | 58 | 0.50 | 0.04 |

| Survey | Raw count | Total unapportioned | | | | |
|---|---|---|---|---|---|---|
| | | Abundance | LCL | UCL | Precision (CV) | Density (km$^2$) |
| **Feb-22** | 2 | 11 | 2 | 33 | 0.71 | 0.02 |
| **Mar-22** | 1 | 5 | 1 | 16 | 1.00 | 0.01 |
| **Jun-22** | 1 | 6 | 1 | 17 | 1.00 | 0.01 |
| **Apr-23** | 1 | 6 | 1 | 17 | 1.00 | 0.01 |

A total of 30 unidentified dolphins / porpoise species were recorded in Caledonia South Survey Area, from May to July and from September to November 2021, from January to March, and in May, June and October 2022, and April 2023 (Table 13). In the Caledonia South Survey Area, a peak of eight individuals were recorded in October 2021, resulting in an unapportioned abundance estimate of 46 [8; 139] individuals, which equated to a mean density estimate of 0.09 mammals/km$^2$ (Table 149).

**Table 149 Raw counts, unapportioned abundance and density estimates (mammals per km$^2$) of unidentified dolphin and / or porpoise species in Caledonia South, Caledonia South plus 2 km buffer and Caledonia South Survey Area during the May 2021 to April 2023 survey period**

| Survey | Raw count | Toal unapportioned | | | | |
|---|---|---|---|---|---|---|
| | | Abundance | LCL | UCL | Precision (CV) | Density (km$^2$) |
| **a) Caledonia South** | | | | | | |
| **May-21** | 3 | 17 | 3 | 52 | 0.58 | 0.08 |
| **Jun-21** | 1 | 6 | 1 | 17 | 1.00 | 0.03 |
| **Jul-21** | 1 | 6 | 1 | 18 | 1.00 | 0.03 |
| **Sep-21** | 1 | 6 | 1 | 17 | 1.00 | 0.03 |
| **Nov-21** | 1 | 6 | 1 | 17 | 1.00 | 0.03 |
| **Jan-22** | 1 | 6 | 1 | 17 | 1.00 | 0.03 |
| **Feb-22** | 2 | 11 | 2 | 32 | 0.71 | 0.05 |
| **Mar-22** | 2 | 11 | 2 | 27 | 0.71 | 0.05 |
| **May-22** | 1 | 6 | 1 | 17 | 1.00 | 0.03 |
| **Jun-22** | 3 | 17 | 3 | 41 | 0.58 | 0.08 |
| **Oct-22** | 1 | 6 | 1 | 18 | 1.00 | 0.03 |
| **Apr-23** | 1 | 6 | 1 | 17 | 1.00 | 0.03 |
| **b) Caledonia South plus 2 km buffer** | | | | | | |
| **May-21** | 3 | 17 | 3 | 52 | 0.58 | 0.05 |
| **Jun-21** | 1 | 6 | 1 | 17 | 1.00 | 0.02 |
| **Jul-21** | 1 | 6 | 1 | 17 | 1.00 | 0.02 |
| **Sep-21** | 1 | 6 | 1 | 17 | 1.00 | 0.02 |
| **Nov-21** | 3 | 17 | 3 | 46 | 0.58 | 0.05 |
| **Jan-22** | 1 | 6 | 1 | 17 | 1.00 | 0.02 |
| **Feb-22** | 2 | 11 | 2 | 32 | 0.71 | 0.03 |
| **Mar-22** | 2 | 11 | 2 | 26 | 0.71 | 0.03 |
| **May-22** | 1 | 6 | 1 | 17 | 1.00 | 0.02 |
| **Jun-22** | 3 | 17 | 3 | 40 | 0.58 | 0.05 |
| **Oct-22** | 1 | 6 | 1 | 17 | 1.00 | 0.02 |
| **Apr-23** | 1 | 6 | 1 | 17 | 1.00 | 0.02 |
| **c) Caledonia South Survey Area** | | | | | | |
| **May-21** | 3 | 17 | 3 | 52 | 0.58 | 0.03 |
| **Jun-21** | 1 | 6 | 1 | 17 | 1.00 | 0.01 |
| **Jul-21** | 1 | 6 | 1 | 18 | 1.00 | 0.01 |
| **Sep-21** | 1 | 6 | 1 | 17 | 1.00 | 0.01 |
| **Oct-21** | 8 | 46 | 8 | 139 | 0.35 | 0.09 |
| **Nov-21** | 3 | 17 | 3 | 46 | 0.58 | 0.03 |
| **Jan-22** | 1 | 6 | 1 | 17 | 1.00 | 0.01 |
| **Feb-22** | 2 | 11 | 2 | 33 | 0.71 | 0.02 |
| **Mar-22** | 2 | 11 | 2 | 27 | 0.71 | 0.02 |

| Survey | Raw count | Toal unapportioned | | | | |
|---|---|---|---|---|---|---|
| | | Abundance | LCL | UCL | Precision (CV) | Density (km²) |
| **May-22** | 1 | 6 | 1 | 17 | 1.00 | 0.01 |
| **Jun-22** | 3 | 17 | 3 | 41 | 0.58 | 0.03 |
| **Oct-22** | 2 | 12 | 2 | 35 | 0.71 | 0.02 |
| **Apr-23** | 2 | 11 | 2 | 29 | 0.71 | 0.02 |

#### *ii. Distribution and behaviour*

Maps of distribution are shown in Appendix 4: Figures A4.369-381. Unidentified dolphins and / or porpoises were recorded in Caledonia South and its Buffer zone in June 2021, January to March, and May 2022, and October 2022 (Figures A4.370, 375-378, 380), whereas they were only recorded in Caledonia North in October 2021 (Figure A4.373). They were recorded scattered across both northern and southern parts of the Survey Area in other months, specifically, in the northwest of Caledonia North Buffer Zone and the northeast of Caledonia South in May 2021 (Figure A4.369), in the west and northeast of Caledonia North Buffer Zone and the east of Caledonia South in July 2021 (Figure A4.371), in the northeast of Caledonia North Buffer Zone and west of Caledonia South in September 2021 (Figure A4.372), in the southwest of Caledonia North Buffer Zone, central north of Caledonia South and the southeast of its Buffer Zone in November 2021 (Figure A4.374), in the centre of Caledonia North and the southeast to south of Caledonia South in June 2022 (Figure A4.379), and in the west of Caledonia North Buffer Zone, and the east and west of Caledonia South in April 2023 (Figure A4.381).

### 4.47 Common minke whale

#### *i. Abundance and density estimates*

A total of 12 common minke whale were recorded in the Survey Area during both years of baseline surveys (Table 11). Common minke whales were recorded in the July 2021 and May to July 2022 (Table 11, Table 150). In the Survey Area, a peak of six common minke whales were recorded in July 2021, resulting in an unapportioned mean abundance estimate of 36 [6; 66] and an apportioned mean abundance estimate of 36 [8; 78] individuals (Table 150). Both equated to a mean density estimate of 0.04 mammals/km$^2$ (Table 150).

Measures of precisions were high (indicating lower levels of precision), which is likely related to the low numbers of individuals recorded in each reporting region during each survey (CV > 0.16, Table 150).

**Table 150 Raw counts, unapportioned and apportioned abundance and density estimates (mammals per km$^2$) of common minke whales in Caledonia OWF, Caledonia OWF plus 2 km buffer and the Survey Area during the May 2021 to April 2023 survey period**

| Survey | Raw count | Total unapportioned | | | | | Total apportioned | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Abundance | LCL | UCL | Precision (CV) | Density (km²) | Abundance | LCL | UCL | Density (km²) |
| **a) Caledonia OWF** | | | | | | | | | | |
| **Jul-21** | 1 | 6 | 1 | 18 | 1.00 | 0.01 | 6 | 1 | 18 | 0.01 |
| **Aug-21** | 0 | - | - | - | - | - | 6 | 1 | 17 | 0.01 |
| **Jun-22** | 1 | 6 | 1 | 17 | 1.00 | 0.01 | 7 | 1 | 20 | 0.02 |
| **b) Caledonia OWF plus 2 km buffer** | | | | | | | | | | |
| **Jul-21** | 4 | 23 | 4 | 46 | 0.5 | 0.04 | 24 | 4 | 58 | 0.04 |
| **Aug-21** | 0 | - | - | - | - | - | 4 | 1 | 11 | 0.01 |
| **May-22** | 1 | 6 | 1 | 17 | 1 | 0.01 | 6 | 1 | 17 | 0.01 |
| **Jun-22** | 1 | 6 | 1 | 17 | 1 | 0.01 | 6 | 1 | 19 | 0.01 |
| **Jul-22** | 1 | 6 | 1 | 17 | 1 | 0.01 | 6 | 1 | 17 | 0.01 |
| **c) Survey Area** | | | | | | | | | | |

| Survey | Raw count | Total unapportioned | | | | | Total apportioned | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Abundance | LCL | UCL | Precision (CV) | Density (km²) | Abundance | LCL | UCL | Density (km²) |
| **Jul-21** | 6 | 36 | 6 | 66 | 0.41 | 0.04 | 36 | 8 | 78 | 0.04 |
| **May-22** | 1 | 6 | 1 | 17 | 1.00 | 0.01 | 6 | 1 | 17 | 0.01 |
| **Jun-22** | 2 | 12 | 2 | 29 | 0.71 | 0.01 | 13 | 2 | 33 | 0.01 |
| **Jul-22** | 3 | 18 | 3 | 35 | 0.58 | 0.02 | 18 | 3 | 35 | 0.02 |

In Caledonia North Survey Area, two common minke whales were recorded in July 2021 (Table 12, Table 151). Abundance and density estimates were therefore very low (Table 151).

**Table 151 Raw counts, unapportioned and apportioned abundance and density estimates (mammals per km²) of common minke whales in Caledonia North, Caledonia North plus 2 km buffer and Caledonia North Survey Area during the May 2021 to April 2023 survey period**

| Survey | Raw count | Total unapportioned | | | | | Total apportioned | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Abundance | LCL | UCL | Precision (CV) | Density (km²) | Abundance | LCL | UCL | Density (km²) |
| **a) Caledonia North** | | | | | | | | | | |
| None recorded | | | | | | | | | | |
| **b) Caledonia North plus 2 km buffer** | | | | | | | | | | |
| **Jul-21** | 1 | 6 | 1 | 17 | 1.00 | 0.02 | 6 | 1 | 17 | 0.02 |
| **c) Caledonia North Survey Area** | | | | | | | | | | |
| **Jul-21** | 2 | 12 | 2 | 30 | 0.71 | 0.02 | 12 | 2 | 30 | 0.02 |

A total of 11 common minke whales were recorded in Caledonia South Survey Area in July 2021 and May to July 2022 (Table 13, Table 152). In Caledonia South Survey Area, a peak of five common minke whales were recorded in July 2021, resulting in an unapportioned and apportioned mean abundance estimate of 30 [5-6; 54-66] individuals and a mean density estimate of 0.06 mammals/km² (Table 152).

Measures of precisions were high (indicating lower levels of precision), which is likely related to the low numbers of individuals recorded in each reporting region during each survey (CV > 0.16, Table 152).

**Table 152 Raw counts, unapportioned and apportioned abundance and density estimates (mammals per km²) of common minke whales in Caledonia South, Caledonia South plus 2 km buffer and Caledonia South Survey Area during the May 2021 to April 2023 survey period**

| Survey | Raw count | Total unapportioned | | | | | Total apportioned | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Abundance | LCL | UCL | Precision (CV) | Density (km²) | Abundance | LCL | UCL | Density (km²) |
| **a) Caledonia South** | | | | | | | | | | |
| **Jul-21** | 1 | 6 | 1 | 18 | 1.00 | 0.03 | 6 | 1 | 18 | 0.03 |
| **Jun-22** | 1 | 6 | 1 | 17 | 1.00 | 0.03 | 6 | 1 | 17 | 0.03 |
| **b) Caledonia South plus 2 km buffer** | | | | | | | | | | |
| **Jul-21** | 4 | 23 | 4 | 47 | 0.50 | 0.06 | 24 | 4 | 58 | 0.07 |
| **May-22** | 1 | 6 | 1 | 17 | 1.00 | 0.02 | 6 | 1 | 17 | 0.02 |
| **Jun-22** | 1 | 6 | 1 | 17 | 1.00 | 0.02 | 6 | 1 | 17 | 0.02 |
| **Jul-22** | 1 | 6 | 1 | 17 | 1.00 | 0.02 | 6 | 1 | 17 | 0.02 |
| **c) Caledonia South Survey Area** | | | | | | | | | | |
| **Jul-21** | 5 | 30 | 6 | 54 | 0.45 | 0.06 | 30 | 5 | 66 | 0.06 |
| **May-22** | 1 | 6 | 1 | 17 | 1.00 | 0.01 | 6 | 1 | 17 | 0.01 |
| **Jun-22** | 2 | 12 | 2 | 29 | 0.71 | 0.02 | 13 | 2 | 32 | 0.02 |
| **Jul-22** | 3 | 17 | 3 | 35 | 0.58 | 0.03 | 17 | 6 | 35 | 0.03 |

### *ii. Distribution and behaviour*

Maps of distribution are shown in Appendix 4: Figure A4.382-385. Common minke whales were largely recorded in Caledonia South and its Buffer Zone, though sporadic records further north were also made. They occurred in proximity to Moray East wind turbines in the west and in the south of the Survey Area in July 2021 (Figure A4.382). The single individual in May 2022 was recorded in the northeast of Caledonia South Buffer Zone (Figure A4.383). In June and July 2022, records were more loosely scattered in comparison, but both months included individuals close to the Moray East wind turbines in the west of the Survey Area and individuals further south (Figures A4.384-385).

## 4.48 Unidentified marine mammal species

### *i. Abundance and density estimates*

A total of four unidentified marine mammals were recorded in the Survey Area during both years of baseline surveys (Table 11). In both August 2021 and December 2022, a single marine mammal was recorded in Caledonia North Survey Area and Caledonia South Survey Area (Table 11 to Table 13, Table 153 to Table 155). The peak abundance was recorded in June 2022, with two individuals recorded in Caledonia North Survey Area (Table 154 to Table 155). The abundance and density estimates were therefore very low (Table 153 to Table 155). Unidentified marine mammal species have been used for apportioning to species level where possible.

**Table 153 Raw counts, unapportioned abundance and density estimates (mammals per km$^2$) of marine mammal species in Caledonia OWF, Caledonia OWF plus 2 km buffer and the Survey Area during the May 2021 to April 2023 survey period**

| Survey | Raw count | Total unapportioned | | | | |
|---|---|---|---|---|---|---|
| | | Abundance | LCL | UCL | Precision (CV) | Density (km$^2$) |
| **a) Caledonia OWF** | | | | | | |
| **Aug-21** | 1 | 6 | 1 | 17 | 1.00 | 0.01 |
| **Jun-22** | 1 | 6 | 1 | 17 | 1.00 | 0.01 |
| **b) Caledonia OWF plus 2 km buffer** | | | | | | |
| **Aug-21** | 1 | 6 | 1 | 17 | 1.00 | 0.01 |
| **Jun-22** | 1 | 6 | 1 | 17 | 1.00 | 0.01 |
| **Dec-22** | 1 | 6 | 1 | 18 | 1.00 | 0.01 |
| **c) Survey Area** | | | | | | |
| **Aug-21** | 1 | 6 | 1 | 17 | 1.00 | 0.01 |
| **Jun-22** | 2 | 12 | 2 | 29 | 0.71 | 0.01 |
| **Dec-22** | 1 | 6 | 1 | 18 | 1.00 | 0.01 |

**Table 154 Raw counts, unapportioned abundance and density estimates (mammals per km$^2$) of marine mammal species in Caledonia North, Caledonia North plus 2 km buffer and Caledonia North Survey Area during the May 2021 to April 2023 survey period**

| Survey | Raw count | Total unapportioned | | | | |
|---|---|---|---|---|---|---|
| | | Abundance | LCL | UCL | Precision (CV) | Density (km$^2$) |
| **a) Caledonia North** | | | | | | |
| **Aug-21** | 1 | 6 | 1 | 17 | 1.00 | 0.03 |
| **Jun-22** | 1 | 6 | 1 | 17 | 1.00 | 0.03 |
| **b) Caledonia North plus 2 km buffer** | | | | | | |
| **Aug-21** | 1 | 6 | 1 | 17 | 1.00 | 0.02 |
| **Jun-22** | 1 | 6 | 1 | 17 | 1.00 | 0.02 |
| **c) Caledonia North Survey Area** | | | | | | |
| **Aug-21** | 1 | 6 | 1 | 17 | 1.00 | 0.01 |
| **Jun-22** | 2 | 12 | 2 | 29 | 0.71 | 0.02 |

**Table 155 Raw counts, unapportioned abundance and density estimates (mammals per km²) of marine mammal species in Caledonia South, Caledonia South plus 2 km buffer and Caledonia South Survey Area during the May 2021 to April 2023 survey period**

| Survey | Raw count | Total unapportioned | | | | |
|---|---|---|---|---|---|---|
| | | Abundance | LCL | UCL | Precision (CV) | Density (km2) |
| **a) Caledonia South** | | | | | | |
| None recorded | | | | | | |
| **b) Caledonia South plus 2 km buffer** | | | | | | |
| **Dec-22** | 1 | 6 | 1 | 17 | 1.00 | 0.02 |
| **c) Caledonia South Survey Area** | | | | | | |
| **Jun-22** | **1** | **6** | 1 | 17 | 1.00 | 0.01 |
| **Dec-22** | **1** | **6** | 1 | 18 | 1.00 | 0.01 |

### *ii. Distribution and behaviour*

A single unidentified marine mammal was recorded in the northeast of Caledonia North in August 2021 (Appendix 4, Figure A4.386), while the individual recorded in December 2022 was located in the southeast of Caledonia South Buffer Zone towards the other end of the Survey Area (Appendix 4, Figure A4.388). In June 2022, the two records were made in northwest of Caledonia North Buffer Zone and the southwest of Caledonia North (Appendix 4, Figure A4.387).

## 4.49 Basking shark

### *i. Abundance and density estimates*

A single basking shark was recorded in the Survey Area during the second year of the baseline surveys (Table 11, Table 13). The individual was recorded in the November 2022, within Caledonia OWF, specifically in Caledonia South (Table 156 to Table 158). The abundance and density estimates were therefore very low (Table 156 to Table 158).

Measures of precisions were high (indicating lower levels of precision), which is likely related to the low numbers of individuals recorded in each region (CV > 0.16, Table 156 to Table 158).

**Table 156 Raw counts, unapportioned and apportioned abundance and density estimates (individuals per km²) of basking sharks in Caledonia OWF, Caledonia OWF plus 2 km buffer and the Survey Area during the May 2021 to April 2023 survey period**

| Survey | Raw count | Total unapportioned | | | | | Total apportioned | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Abundance | LCL | UCL | Precision (CV) | Density (km²) | Abundance | LCL | UCL | Density (km²) |
| **a) Caledonia OWF** | | | | | | | | | | |
| **Nov-22** | 1 | 6 | 1.00 | 18 | 1 | 0.01 | 6 | 1 | 18 | 0.01 |
| **b) Caledonia OWF plus 2 km buffer** | | | | | | | | | | |
| **Nov-22** | 1 | 6 | 1.00 | 17 | 1 | 0.01 | 6 | 1 | 17 | 0.01 |
| **c) Survey Area** | | | | | | | | | | |
| **Nov-22** | 1 | 6 | 1.00 | 18 | 1 | 0.01 | 6 | 1 | 17 | 0.01 |

**Table 157 Raw counts, unapportioned and apportioned abundance and density estimates (individuals per km²) of basking shark in Caledonia North, Caledonia North plus 2 km buffer and Caledonia North Survey Area during the May 2021 to April 2023 survey period**

| Survey | Raw count | Total unapportioned | | | | | Total apportioned | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Abundance | LCL | UCL | Precision (CV) | Density (km²) | Abundance | LCL | UCL | Density (km²) |
| **a) Caledonia North** | | | | | | | | | | |
| None recorded | | | | | | | | | | |

| Survey | Raw count | Total unapportioned | | | | | Total apportioned | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Abundance | LCL | UCL | Precision (CV) | Density (km²) | Abundance | LCL | UCL | Density (km²) |
| **b) Caledonia North plus 2 km buffer** | | | | | | | | | | |
| None recorded | | | | | | | | | | |
| **c) Caledonia North Survey Area** | | | | | | | | | | |
| None recorded | | | | | | | | | | |

**Table 158 Raw counts, unapportioned and apportioned abundance and density estimates (individuals per km²) of basking shark in Caledonia South, Caledonia South plus 2 km buffer and Caledonia South Survey Area during the May 2021 to April 2023 survey period**

| Survey | Raw count | Total unapportioned | | | | | Total apportioned | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Abundance | LCL | UCL | Precision (CV) | Density (km²) | Abundance | LCL | UCL | Density (km²) |
| **a) Caledonia South** | | | | | | | | | | |
| **Nov-22** | 1 | 6 | 1 | 18 | 1.00 | 0.03 | 6 | 1 | 18 | 0.03 |
| **b) Caledonia South plus 2 km buffer** | | | | | | | | | | |
| **Nov-22** | 1 | 6 | 1 | 17 | 1.00 | 0.02 | 6 | 1 | 17 | 0.02 |
| **c) Caledonia South Survey Area** | | | | | | | | | | |
| **Nov-22** | 1 | 6 | 1 | 18 | 1.00 | 0.01 | 6 | 1 | 18 | 0.01 |

#### *ii. Distribution and behaviour*

The only basking shark recorded, in November 2022, was located in the southwest of Caledonia South (Appendix 4, Figure A4.389).

### 4.50 Unidentified shark species

#### *i. Abundance and density estimates*

A single unidentified shark species was recorded in the Survey Area during the second year of the baseline surveys (Table 11). The individual was recorded in the January 2022 in the 4 km Buffer Zone of the Survey Area, specifically within Caledonia South 4 km buffer (Table 159 to Table 161). The abundance and density estimates were therefore very low (Table 159 to Table 161).

**Table 159 Raw counts, unapportioned abundance and density estimates (individuals per km²) of shark species in Caledonia OWF, Caledonia OWF plus 2 km buffer and the Survey Area during the May 2021 to April 2023 survey period**

| Survey | Raw count | Total unapportioned | | | | |
|---|---|---|---|---|---|---|
| | | Abundance | LCL | UCL | Precision (CV) | Density (km²) |
| **a) Caledonia OWF** | | | | | | |
| None recorded | | | | | | |
| **b) Caledonia OWF plus 2 km buffer** | | | | | | |
| None recorded | | | | | | |
| **c) Survey Area** | | | | | | |
| **Jan-22** | 1 | 6 | 1 | 17 | <1 | 0.01 |

**Table 160 Raw counts, unapportioned abundance and density estimates (individuals per km$^2$) of shark species in Caledonia North, Caledonia North plus 2 km buffer and Caledonia North Survey Area during the May 2021 to April 2023 survey period**

| Survey | Raw count | Total unapportioned | | | | |
|---|---|---|---|---|---|---|
| | | Abundance | LCL | UCL | Precision (CV) | Density (km$^2$) |
| **a) Caledonia North** | | | | | | |
| None recorded | | | | | | |
| **b) Caledonia North plus 2 km buffer** | | | | | | |
| None recorded | | | | | | |
| **c) Caledonia North Survey Area** | | | | | | |
| None recorded | | | | | | |

**Table 161 Raw counts, unapportioned abundance and density estimates (individuals per km$^2$) of shark species in Caledonia South, Caledonia South plus 2 km buffer and Caledonia South Survey Area during the May 2021 to April 2023 survey period**

| Survey | Raw count | Total unapportioned | | | | |
|---|---|---|---|---|---|---|
| | | Abundance | LCL | UCL | Precision (CV) | Density (km$^2$) |
| **a) Caledonia South** | | | | | | |
| None recorded | | | | | | |
| **b) Caledonia South plus 2 km buffer** | | | | | | |
| None recorded | | | | | | |
| **c) Caledonia South Survey Area** | | | | | | |
| **Jan-22** | 1 | 6 | 1 | 17 | 1.00 | 0.01 |

### *i. Distribution and behaviour*

The single unidentified shark was recorded in the east of Caledonia South Buffer Zone towards its outer border (Appendix 4, Figure A4.390).

# 5. Anecdotal observations

Anecdotal observations visually recorded from the aircraft during the 24 months of surveys with respect to anthropogenic activities within the Survey Area are presented in Table 162. Anthropogenic observations recorded in the imagery during the 24 months of surveys within the Survey Area are presented in Table 163.

**Table 162 Summary of anthropogenic activities visually recorded from the aircraft during each survey flight of the May 2021 to April 2023 survey period**

| Survey No. | Date | No. observations | Anthropogenic structure | Time of record | Heading direction |
|---|---|---|---|---|---|
| **1** | 15-May-21 | 1 | Tanker | 14:24 | WNW |
| **2** | 10-Jun-21 | 1 | Cargo vessel | 18:25 | W |
| **3** | 2-Jul-21 | 1 | Transport crew vessel | 11:33 | Unidentified |
| **4** | 1-Aug-21 | 5 | 4 fishing vessels<br>1 unspecified red boat | 19:17, 19:18, 19:31<br>19:14 | Unidentified |
| **5** | 14-Sep-21 | 6 | 3 fishing vessels<br>2 small rig boats<br>1 pleasure boat | 11:08, 11:42, 12:39<br>11:47<br>11:42 | Unidentified |
| **6** | 4-Oct-21 | 0 | - | - | - |
| **7** | 15-Nov-21 | 0 | - | - | - |
| **8** | 6-Dec-21 | 0 | - | - | - |
| **9** | 9-Jan-22 | 0 | - | - | - |
| **10** | 13-Feb-22 | 2 | Small fishing vessels | 12:18 | ESE |
| **11** | 2-Mar-22 | 1 | Wind farm service vessel | 10:33 | Stationary (working) |
| **12** | 26-Apr-22 | 1 | Small fishing vessel | 12:47 | NNE |
| **13** | 14-May-22 | 0 | - | - | - |
| **14** | 4-Jun-22 | 0 | - | - | - |
| **15** | 5-Jul-22 | 3 | Speed boat<br>Small rig boat<br>Rig boat | 17:23<br>17:34<br>18:33 | E<br>N<br>N |
| **16** | 10-Aug-22 | 1 | Wind Cat | 08:59 | Stationary |
| **17** | 11-Sep-22 | 0 | - | - | - |
| **18** | 14-Oct-22 | 3 | 2 Trawlers<br>1 Fishing vessel | 11:32, 11:54<br>12:03 | E, W<br>ESE |
| **19** | 25-Nov-22 | 1 | Large red vessel working around turbines | 10:34 | W |
| **20** | 17-Dec-22 | 0 | - | - | - |
| **21** | 9-Jan-23 | 0 | - | - | - |
| **22** | 13-Feb-23 | 0 | - | - | - |
| **23** | 10-Mar-23 | 1 | Possibly a Royal National Lifeboat Institution (RNLI) vessel | 16:13 | NW |
| **24** | 04-Apr-23 | 1 | Research vessel | 11:08 | S |

**Table 163 Summary of anthropogenic structures recorded in the imagery of the Survey Area during each monthly survey of the May 2021 to April 2023 survey period**

| Survey No. | Date | No. observations | Fixed structure | Vessel |
|---|---|---|---|---|
| **1** | 15-May-21 | 10 | 1 Buoy<br>2 Wind turbines<br>6 Wind turbine bases | 1 Cargo ship (13:28) |
| **2** | 10-Jun-21 | 8 | 1 Buoy<br>5 Wind turbines<br>2 Wind turbine bases | |
| **3** | 2-Jul-21 | 12 | 1 Buoy<br>9 Wind turbines | 1 Supply vessel (10:52)<br>1 Wind carrier (10:52) |
| **4** | 1-Aug-21 | 10 | 1 Buoy<br>9 Wind turbines | |
| **5** | 14-Sep-21 | 12 | 1 Buoy<br>8 Wind turbines | 1 Fishing vessel (9:58)<br>1 Passenger vessel (11:09)<br>1 Sailing boat (10:39) |
| **6** | 4-Oct-21 | 9 | 1 Buoy<br>8 Wind turbines | |
| **7** | 15-Nov-21 | 8 | 1 Buoys<br>7 Wind turbines | |
| **8** | 6-Dec-21 | 9 | 1 Buoy<br>8 Wind turbines | |
| **9** | 9-Jan-22 | 9 | 1 Buoy<br>8 Wind turbines | |
| **10** | 13-Feb-22 | 9 | 1 Buoy<br>8 Wind turbines | |
| **11** | 2-Mar-22 | 9 | 1 Buoy<br>8 Wind turbines | |
| **12** | 26-Apr-22 | 10 | 1 Buoy<br>8 Wind turbines | 1 Fishing vessel (12:07) |
| **13** | 14-May-22 | 9 | 8 Wind turbines | 1 Fishing vessel (11:00) |
| **14** | 4-Jun-22 | 8 | 7 Wind turbines | 1 Supply vessel (15:35) |
| **15** | 5-Jul-22 | 9 | 8 Wind turbines | 1 Supply vessel (16:53) |
| **16** | 10-Aug-22 | 8 | 8 Wind turbines | |
| **17** | 11-Sep-22 | 7 | 7 Wind turbines | |
| **18** | 14-Oct-22 | 8 | 7 Wind turbines | 1 Miscellaneous vessel (10:50) |
| **19** | 25-Nov-22 | 8 | 8 Wind turbines | |
| **20** | 17-Dec-22 | 7 | 7 Wind turbines | |
| **21** | 9-Jan-23 | 8 | 7 Wind turbines | 1 Miscellaneous vessel (10:00) |
| **22** | 13-Feb-23 | 7 | 7 Wind turbines | |
| **23** | 10-Mar-23 | 9 | 8 Wind turbines | 1 Supply vessel (16:13) |
| **24** | 04-Apr-23 | 7 | 7 Wind turbines | |

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# Appendix 1 - Scientific names and taxonomy

| Common Name | Scientific Name | Family | Class |
|---|---|---|---|
| Pink-footed goose | *Anser brachyrhynchus* | Anatidae | Aves |
| Mallard | *Anas platyrhynchos* | Anatidae | Aves |
| Kittiwake | *Rissa tridactyla* | Laridae | Aves |
| Common gull | *Larus canus* | Laridae | Aves |
| Great black-backed gull | *Larus marinus* | Laridae | Aves |
| Herring gull | *Larus argentatus* | Laridae | Aves |
| Lesser black-backed gull | *Larus fuscus* | Laridae | Aves |
| Common tern | *Sterna hirundo* | Laridae | Aves |
| Arctic tern | *Sterna paradisaea* | Laridae | Aves |
| Great skua | *Stercorarius skua* | Stercorariidae | Aves |
| Arctic skua | *Stercorarius parasiticus* | Stercorariidae | Aves |
| Guillemot | *Uria aalge* | Alcidae | Aves |
| Razorbill | *Alca torda* | Alcidae | Aves |
| Black guillemot | *Cepphus grylle* | Alcidae | Aves |
| Puffin | *Fratercula arctica* | Alcidae | Aves |
| Great northern diver | *Gavia immer* | Gaviidae | Aves |
| Red-throated diver | *Gavia stellata* | Gaviidae | Aves |
| Fulmar | *Fulmarus glacialis* | Procellariidae | Aves |
| Sooty shearwater | *Ardenna grisea* | Procellariidae | Aves |
| Manx shearwater | *Puffinus puffinus* | Procellariidae | Aves |
| Gannet | *Morus bassanus* | Sulidae | Aves |
| Grey seal | *Halichoerus grypus* | Phocidae | Mammalia |
| Common dolphin | *Delphinus delphis* | Delphinidae | Mammalia |
| White-beaked dolphin | *Lagenorhynchus albirostris* | Delphinidae | Mammalia |
| Bottlenose dolphin | *Tursiops truncatus* | Delphinidae | Mammalia |
| Risso's dolphin | *Grampus griseus* | Delphinidae | Mammalia |
| Harbour porpoise | *Phocoena phocoena* | Phocoenidae | Mammalia |
| Common minke whale | *Balaenoptera acutorostrata* | Balaenopteridae | Mammalia |
| Basking shark | *Cetorhinus maximus* | Cetorhinidae | Chondrichthyes |

## Appendix 2 - Species identification rates

Identification (ID) rates are provided according to groups presented in Table 5 for birds and Table 6 for marine mammals (reiterated below: Table A2.1, Table A2.2). Unidentified bird species have not been included in the ID rate calculations due to the low number observed during the survey period (n=32 in year 1; n=36 in year 2) and the broadness of the grouping. Identification rate of an individual to the species level, from May 2021 to April 2022 and from May 2022 to April 2023, specific to Caledonia OWF project, are presented hereafter (Table A2.3, Table A2.4). The ID rates were calculated from the raw counts of species observation in Caledonia Survey Area. Species positively identified to species level, i.e. recorded 100% to species level (level 1), do not form part of the higher-level groupings.

**Table A2.1 Individual bird species and grouping levels, these are shown in 5 levels of groupings**

<table>
<tr><th>Species Level 1</th><th>Group Level 2</th><th>Group Level 3</th><th>Group Level 4</th><th>Group Level 5</th></tr>
<tr><td>Great northern diver</td><td rowspan="2">Diver species</td><td rowspan="2">-</td><td rowspan="2">-</td><td rowspan="2">-</td></tr>
<tr><td>Red-throated diver</td></tr>
<tr><td>Kittiwake</td><td colspan="2" rowspan="2">Small gulls</td><td rowspan="5">Gull species</td><td rowspan="6">Fulmar / Gull species</td></tr>
<tr><td>Common Gull</td></tr>
<tr><td>Great Black-backed Gull</td><td rowspan="2">Black-backed gulls</td><td rowspan="3">Large gulls</td></tr>
<tr><td>Lesser Black-backed Gull</td></tr>
<tr><td>Herring Gull</td><td colspan="2"></td></tr>
<tr><td>Fulmar</td><td colspan="2">-</td><td>-</td></tr>
<tr><td>Common tern</td><td colspan="2" rowspan="2">‘Commic’ tern</td><td rowspan="2">Tern species</td><td>-</td></tr>
<tr><td>Arctic tern</td><td>-</td></tr>
<tr><td>Guillemots</td><td rowspan="3">Guillemots / Razorbill</td><td colspan="2" rowspan="3">Auk species</td><td rowspan="5">Auk / Shearwater species</td></tr>
<tr><td>Razorbill</td></tr>
<tr><td>Black guillemot</td></tr>
<tr><td>Puffin</td><td colspan="3"></td></tr>
<tr><td>Sooty shearwater</td><td>-</td><td rowspan="2">Large shearwater species</td><td rowspan="2">Shearwater species</td></tr>
<tr><td>Manx shearwater</td><td>-</td></tr>
</table>

**Table A2.2 Individual marine mammal species and their grouping levels, these are shown in 4 levels of groupings**

<table>
<tr><th>Species Level 1</th><th>Group Level 2</th><th>Group Level 3</th><th>Group Level 4</th></tr>
<tr><td>Grey seal</td><td colspan="2">Seal species</td><td rowspan="6">Unidentified marine mammal Species</td></tr>
<tr><td>Common dolphin</td><td rowspan="4">Dolphin Species</td><td rowspan="5">Dolphin / porpoise species</td></tr>
<tr><td>White-beaked dolphin</td></tr>
<tr><td>Bottlenose dolphin</td></tr>
<tr><td>Risso’s dolphin</td></tr>
<tr><td>Harbour porpoise</td><td>Porpoise species</td></tr>
<tr><td>Common minke whale</td><td colspan="2">Whale species</td></tr>
<tr><td>Basking shark</td><td colspan="2">Shark species</td><td>-</td></tr>
</table>

**Table A2.3 Monthly identification rates of species recorded across year 1 (May 2021 to April 2022)**

| Common Name | May 21 | Jun 21 | Jul 21 | Aug 21 | Sep 21 | Oct 21 | Nov 21 | Dec 21 | Jan 22 | Feb 22 | Mar 22 | Apr 22 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | ID Species Level 1 (%) | | | | | | | | | | | |
| Mallard | - | - | - | - | - | - | - | - | - | 100 | - | - |
| Kittiwake | 99.5 | 100 | 99.9 | 99.3 | 100 | 100 | 100 | 100 | 100 | 96.7 | 100 | 100 |
| Common gull | - | - | - | - | 100 | - | 100 | - | - | - | - | - |
| Great black-backed gull | - | - | - | 60 | 95 | 90.2 | 90.1 | 100 | 98 | 97.7 | 66.7 | - |
| Lesser black-backed gull | - | - | 42.9 | - | - | - | - | - | - | - | - | - |
| Herring gull | 50 | 100 | 84.2 | | 20 | 58.3 | 46.7 | 100 | 50 | 87.5 | 50 | - |
| Common tern | - | - | - | 60 | - | - | - | - | - | - | - | - |
| Arctic tern | 69.2 | - | - | - | - | - | - | - | - | - | - | - |
| Great skua | 100 | 100 | 100 | - | 100 | - | - | - | - | - | - | - |
| Guillemot | 91.2 | 71.1 | 95.2 | 16.3 | 81.3 | 73.9 | 92.7 | 8 | 71 | 40.3 | 69.1 | 86.3 |
| Razorbill | 48.6 | 27.4 | 68.8 | 9.4 | 30.1 | 9.6 | - | 2.8 | 18.2 | 21.5 | 18.3 | 67.6 |
| Black guillemot | - | 0.2 | - | - | - | - | - | - | - | - | - | 1.4 |
| Puffin | 86.4 | 77.8 | 65.2 | 74.7 | 67.6 | 70.9 | - | - | - | - | 40 | 90.2 |
| Great northern diver | - | 100 | - | - | - | - | 100 | - | - | - | - | - |
| Fulmar | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| Manx shearwater | 9.1 | 51.7 | 18.8 | - | - | - | - | - | - | - | - | - |
| Sooty shearwater | - | - | - | - | 100 | - | - | - | - | - | - | - |
| Gannet | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| | | | | | | | | | | | | |
| Grey seal | - | 33.3 | - | - | 100 | 100 | 100 | - | 100 | - | - | - |
| White-beaked dolphin | - | - | - | - | 50 | 20 | 57.1 | 100 | 50 | 80 | - | - |
| Harbour porpoise | 42.9 | 66.7 | 40 | - | 60 | 60 | - | 100 | - | 50 | 80 | 100 |
| Common minke whale | - | - | 100 | - | - | - | - | - | - | - | - | - |

**Table A2.4 Monthly identification rates of species recorded across year 2 (May 2022 to April 2023)**

| Common Name | May 22 | Jun 22 | Jul 22 | Aug 22 | Sep 22 | Oct 22 | Nov 22 | Dec 22 | Jan 23 | Feb 23 | Mar 23 | Apr 23 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | ID Species Level 1 (%) | | | | | | | | | | | |
| Pink-footed goose | - | - | - | - | - | - | - | - | 100 | - | - | - |
| Kittiwake | 100 | 100 | 100 | 99.1 | 100 | 100 | 89.5 | 80 | 100 | 100 | 94.1 | 100 |
| Common gull | - | - | - | 50 | - | - | - | 50 | - | - | - | - |
| Great black-backed gull | - | - | - | 60 | 100 | 97.4 | 86.4 | 92 | 100 | 100 | 83.3 | - |
| Lesser black-backed gull | 100 | 100 | 33.3 | - | - | - | - | - | - | - | - | - |
| Herring gull | - | 100 | 70.7 | - | - | 75 | 50 | 80 | - | 100 | 50 | - |
| Common tern | - | - | - | - | - | - | - | - | - | - | - | - |
| Arctic tern | - | - | - | 42.9 | - | - | - | - | - | - | - | - |
| Great skua | - | - | 100 | - | - | - | - | - | - | - | - | - |
| Arctic skua | - | - | - | 100 | - | - | - | - | - | - | - | - |
| Guillemot | 90.1 | 97.4 | 91.4 | 77.2 | 85.1 | 57.4 | 31.9 | 80.2 | 95.5 | 92.2 | 90.5 | 92.9 |
| Razorbill | 54.4 | 36.5 | 45.7 | 60.8 | 59.1 | - | 33.3 | 45.9 | 74.1 | 63.5 | 61.3 | 72.3 |
| Black guillemot | - | 3.2 | - | - | - | - | - | - | - | - | - | - |
| Puffin | 86.3 | 65.8 | 70.9 | 93.3 | 80.5 | 57.1 | - | - | 83.3 | 77.8 | 60.9 | 47.6 |
| Red-throated diver | - | - | - | - | - | 100 | - | - | - | - | - | - |
| Fulmar | 100 | 100 | 100 | 100 | 100 | 100 | 99.2 | 100 | 100 | 100 | 99 | 100 |
| Manx shearwater | 50 | - | - | - | - | - | - | - | - | - | - | - |
| Gannet | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| | | | | | | | | | | | | |
| Grey seal | - | 40 | - | 100 | 100 | 100 | 50 | 25 | 100 | 66.7 | 66.7 | - |
| Common dolphin | - | - | - | - | - | 95.1 | - | - | | - | - | - |
| Bottlenose dolphin | 66.7 | - | - | - | - | - | - | - | | - | - | - |
| Risso's dolphin | - | - | - | 100 | 100 | - | - | - | - | - | - | - |
| White-beaked dolphin | - | - | - | - | 100 | 81.8 | - | - | 100 | 100 | - | - |
| Harbour porpoise | 90.9 | 78.6 | 100 | 100 | 100 | - | 100 | 50 | 100 | 100 | 100 | 57.1 |
| Common minke whale | 100 | 50 | 100 | - | - | - | - | - | - | - | - | - |
| Basking shark | - | - | - | - | - | - | 100 | - | - | - | - | - |

# Appendix 3 – Correction factors

Diving birds, and marine mammals spend time foraging beneath the water surface. As a result of this, an unknown number of birds and marine mammals may go undetected due to the snapshot nature of aerial survey techniques. Consequently, abundance and density estimates were adjusted to account for these unobserved individuals with species-specific correction factors.

## Guillemot and razorbill

The correction factor applied to each relevant species is based on that recommended by JNCC in a submission during the examination phase of the East Anglia ONE OWF, referred to by JNCC as Method C[1]. A copy of the text on Method C is provided below. This has been taken from Paragraph 5.6.5 of this document:

> METHOD C
>
> Guillemots
>
> Underwater (1.9h) / [Sea surface (5.1h) + Diving activity (2.9h)] = 0.2375
>
> Therefore, for **guillemot availability** JNCC would calculate ***g(0)* = 0.7625**
>
> Razorbills
>
> Underwater (0.8h) / [Sea surface (3.1h) + Diving activity (1.5h)] = 0.1739
>
> Therefore, for **razorbill availability** JNCC would calculate ***g(0)* = 0.8261**
>
> This works on the following assumptions:
>
> 1. That all birds observed on the water in the project area are undertaking a foraging trip (in most cases this seems appropriate);
> 2. That 'birds in flight' are adequately characterised within the 'birds in flight' quotion of the Thaxter et al. (2010) figures (i.e. that portion which has been removed from the Correction Factor calculation;
> 3. That the proportions of time spent foraging underwater are representative of behaviour throughout the year (i.e. not just the breeding season – the period in which this proportional data was calculated from by Thaxter et al. 2010), should the Correction Factor be applied to annual abundance estimates.

## Puffin

The correction factor applied to puffins is 1.165, which is based on the assumption that 14% puffins are assumed to be underwater at any time[2].

[1] Joint Nature Conservation Committee, 2013. JNCC Expert Statement on Ornithological Issues for Written Representations in Respect of East Anglia ONE Offshore Windfarm by Dr Sophy Allen. *Joint Nature Conservation Committee, Aberdeen*.

[2] Spencer, S.M. (2012). Diving behaviour and identification of sex of breeding Atlantic puffins (Fratercula arctica), and nest-site characteristics of Alcids on Petit Manan Island, Maine. MSc Thesis submitted to University of Massachusetts Amherst in May 2012.

### Harbour porpoise

Aerial digital surveys are commonly used to capture marine mammals for baseline characterisation of offshore wind farm sites in the UK. The benefit of this method includes the permanent record, which allows for third party corroboration on species identification as well as allowing for group size and behaviour to be re-examined, if required.

The correction factors, which were applied to harbour porpoise monthly abundance estimates, are described in Voet *et al.* (2017)[3]. This was based on a study by Teilmann *et al.* (2013)[4], which tagged 35 harbour porpoises in the waters around Denmark using satellite transmitters. The satellite tags collected data on average for 135 days (minimum was 25 days and maximum was 349 days). Amongst other variables studied, the percentage of time spent in the upper 2 metres (m) of the water column was recorded and analysed. No significant difference in time spent in the upper 2m between sex or geographical location of tagging was found. There was also no significant correlation between the length of the harbour porpoise and time spent at 0-2m. However, the variable month was identified as having a significant effect, which varied between seasons. Therefore, correction factors were applied to the total abundance (surfacing and submerged individuals) as per Teilmann *et al.* (2013) recommendation. The correction factors applied are provided in Table A3.164.

**Table A3.164 Seasonal harbour porpoise correction factors**

| Season | Correction Factor |
|---|---|
| Spring (Mar-May) | 0.571 |
| Summer (Jun-Aug) | 0.547 |
| Autumn (Sep-Nov) | 0.455 |
| Winter (Dec-Feb) | 0.472 |

[3] Voet H., Rehfisch M., McGovern S. and Sweeney S. (2017) Marine Mammal Correction Factor for Availability Bias in Aerial Digital Still surveys. Case Study: Harbour porpoise (*Phocoena phocoena*) in the Southern North Sea. APEM Ltd.

[4] Teilmann J, Christiansen CT, Kjellerup S, Dietz R and Nachman G (2013) 'Geographic, seasonal and diurnal surface behaviour of harbour porpoise'. Marine Mammal Science 29(2): E60-E76.

# Appendix 4 – Distribution maps

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## Pink-footed goose

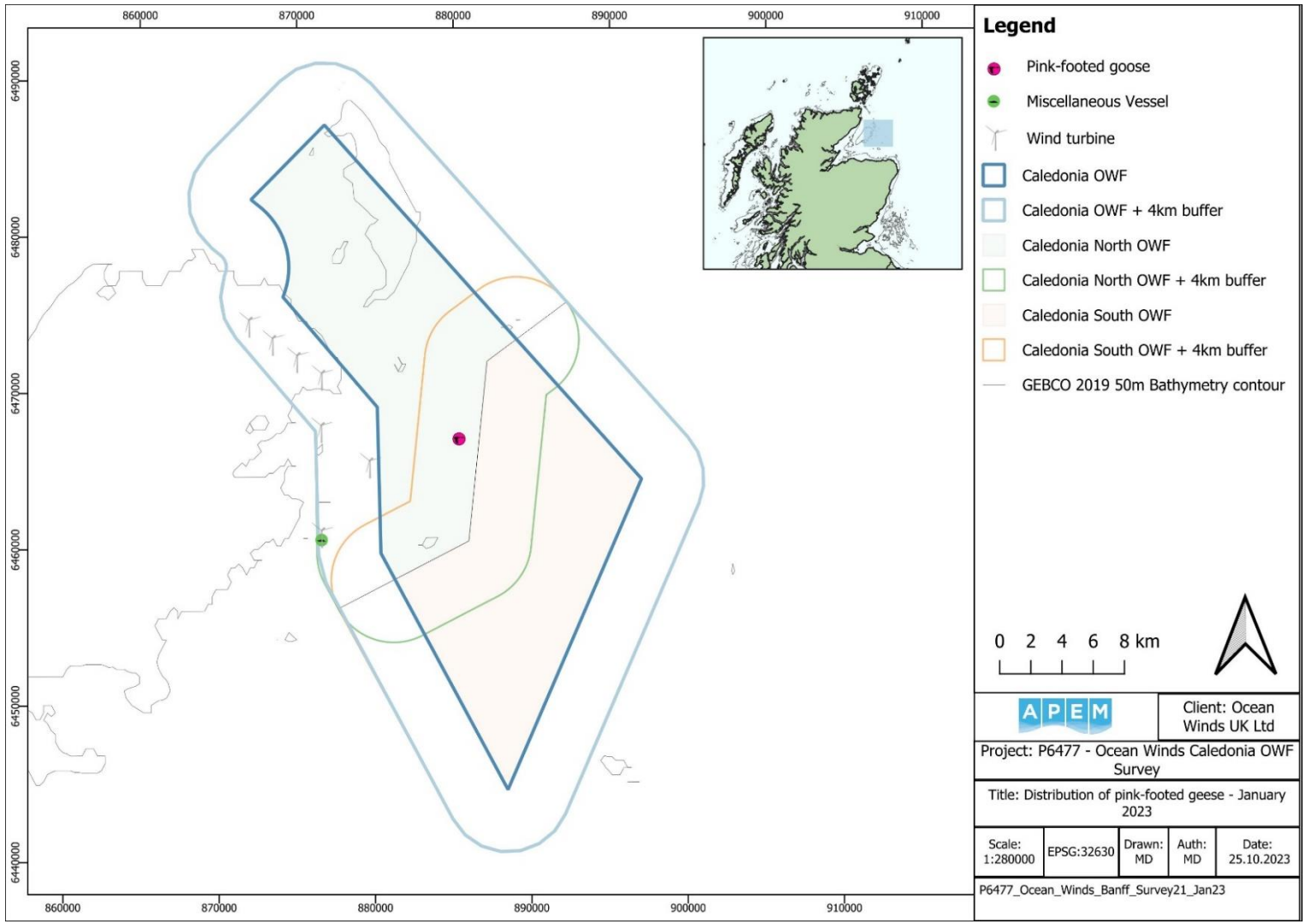



**Figure A4.43 Distribution of pink-footed geese recorded in the Survey Area in January 2023**

## Mallard

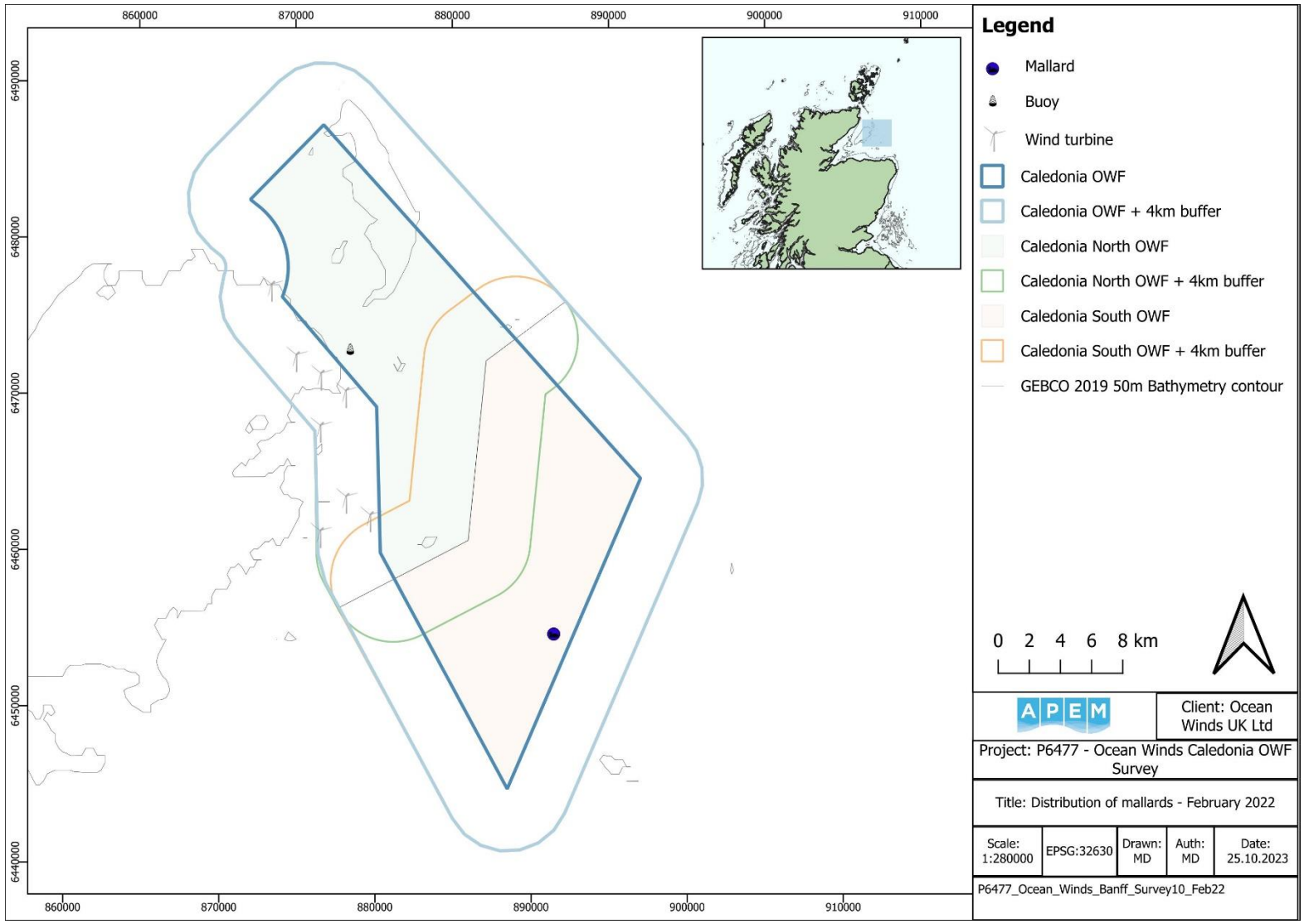



**Figure A4.44 Distribution of mallard recorded in the Survey Area in February 2022**

## Unidentified wader species

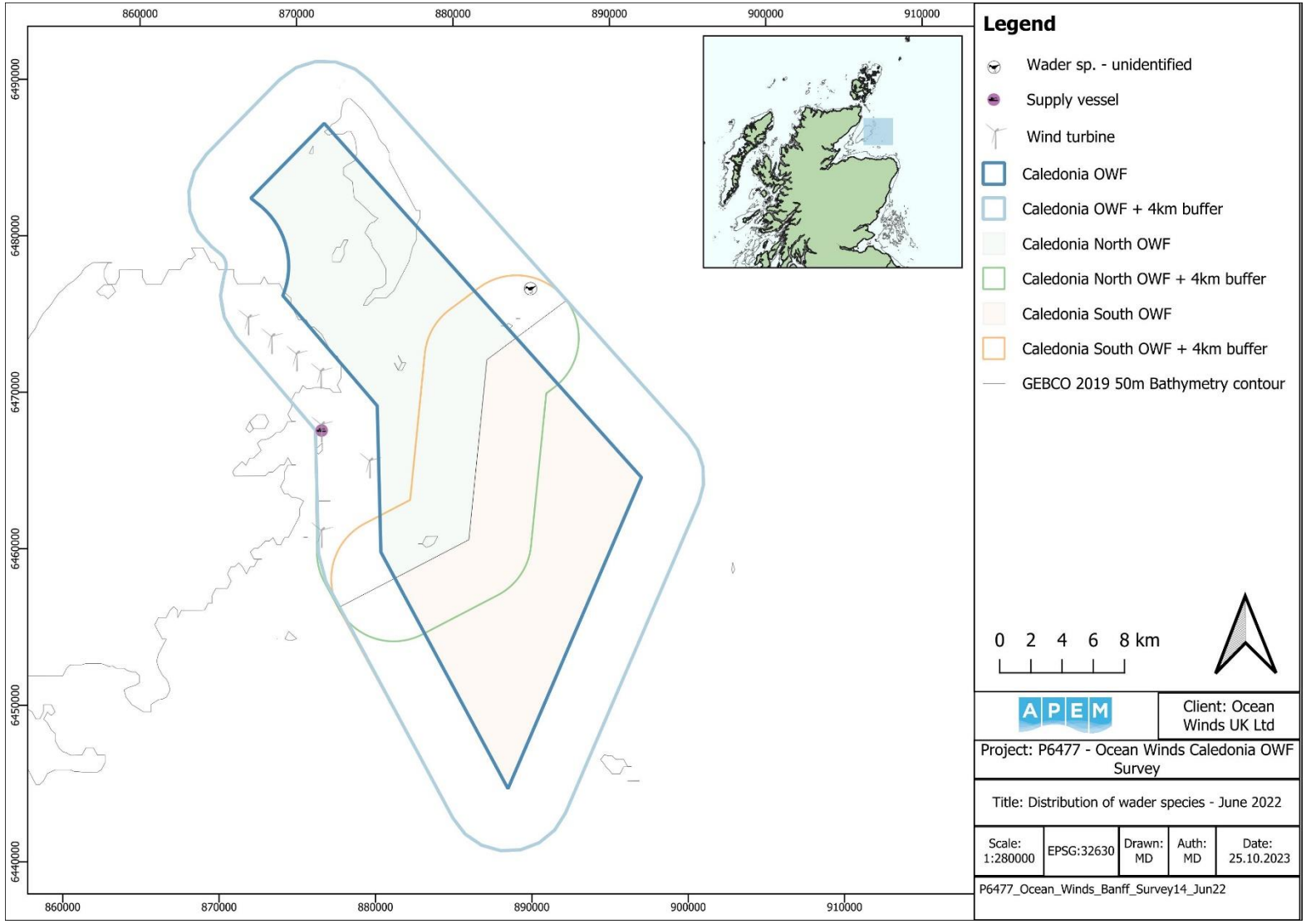



**Figure A4.45 Distribution of wader species recorded in the Survey Area in June 2022**

## Kittiwake

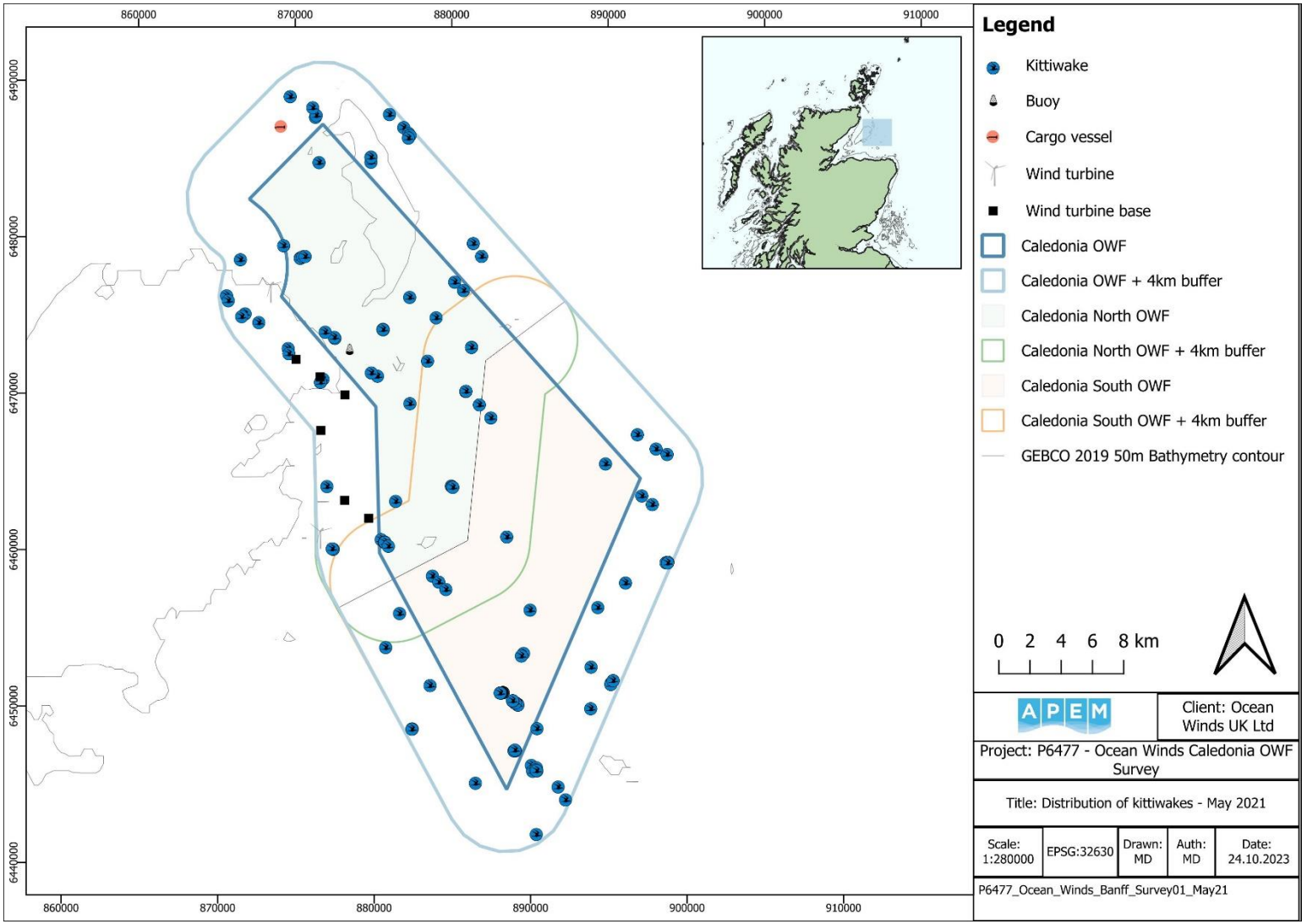



**Figure A4.46 Distribution of kittiwakes recorded in the Survey Area in May 2021**

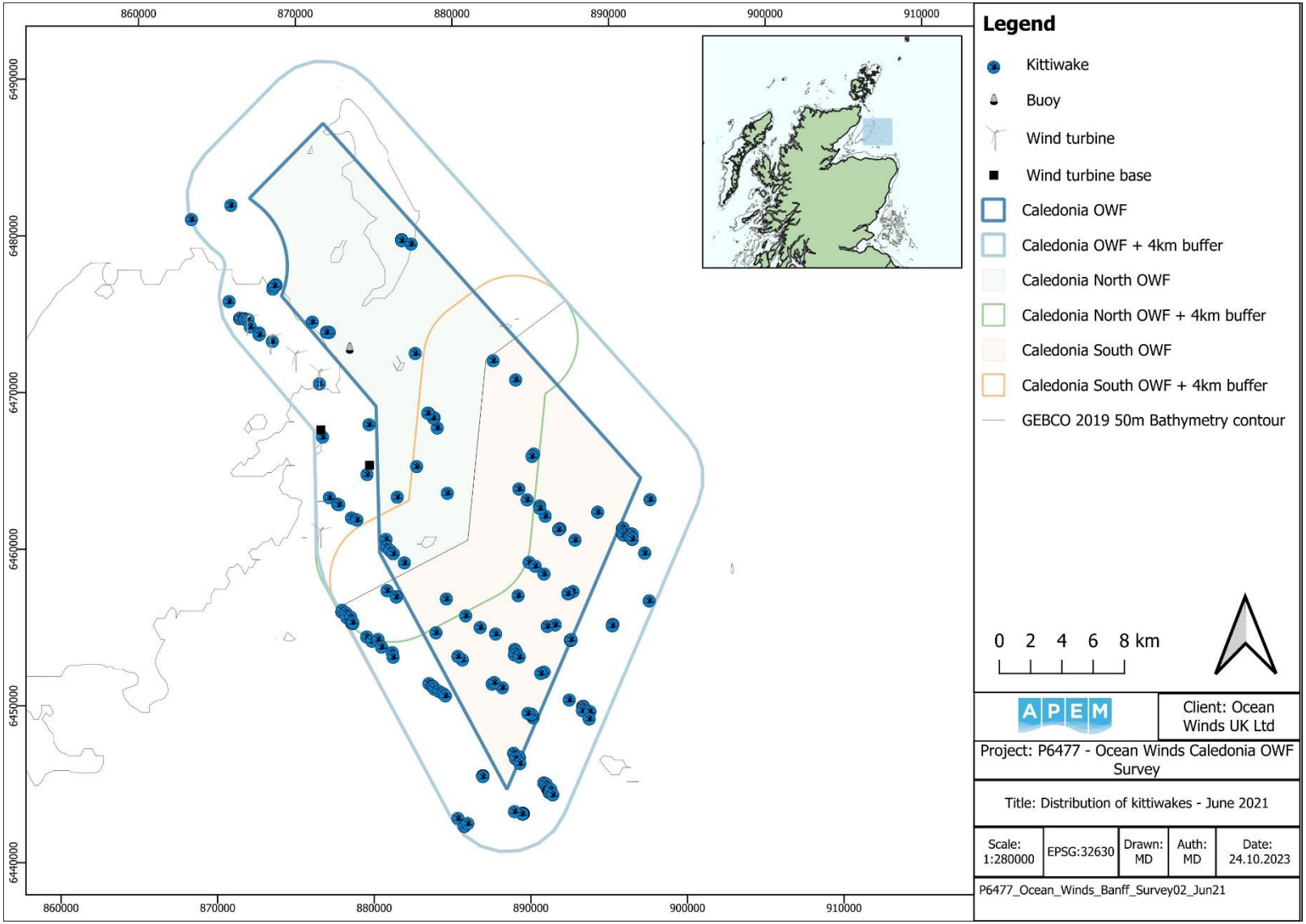



**Figure A4.47 Distribution of kittiwakes recorded in the Survey Area in June 2021**

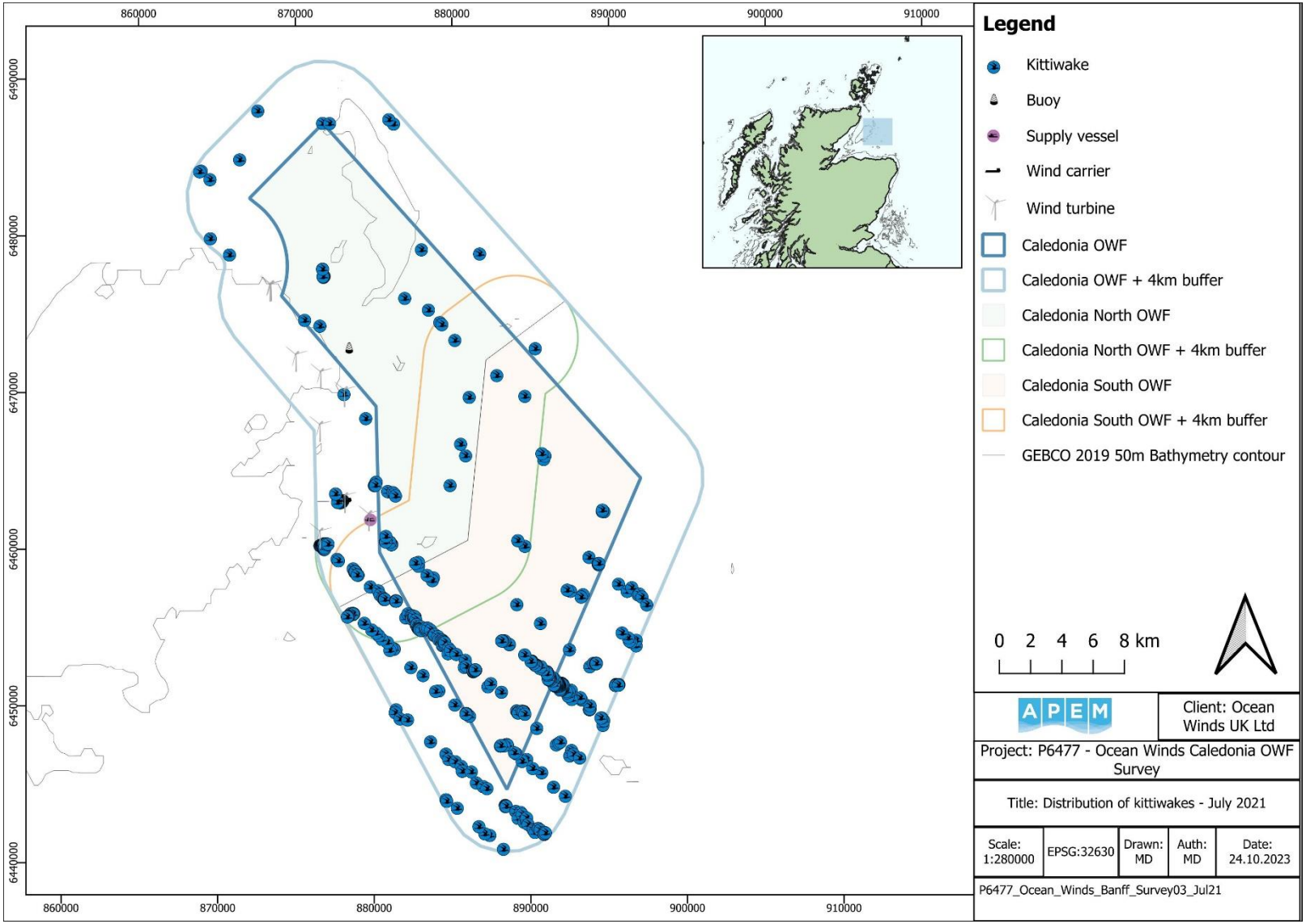



**Figure A4.48 Distribution of kittiwakes recorded in the Survey Area in July 2021**

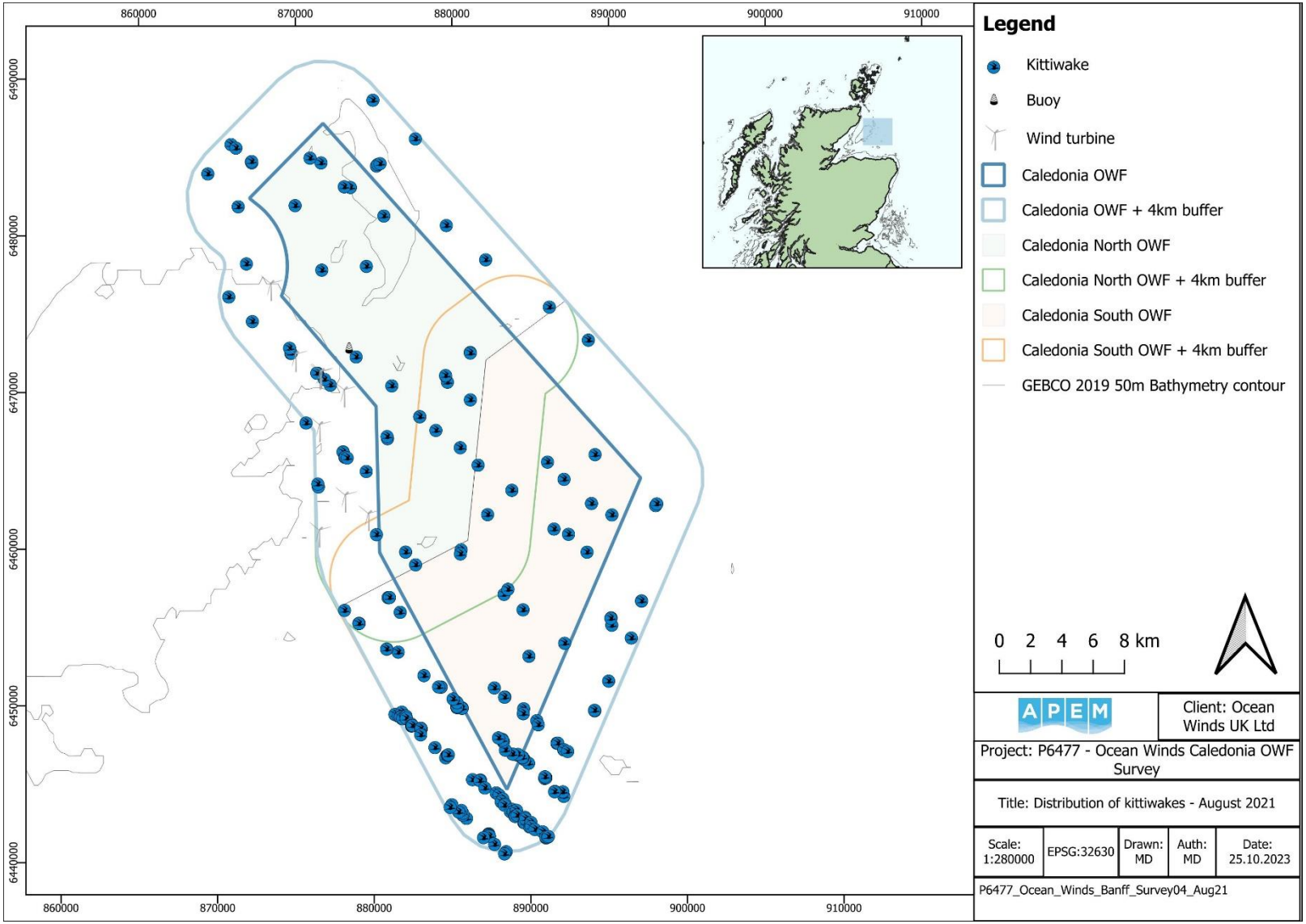



**Figure A4.49 Distribution of kittiwakes recorded in the Survey Area in August 2021**

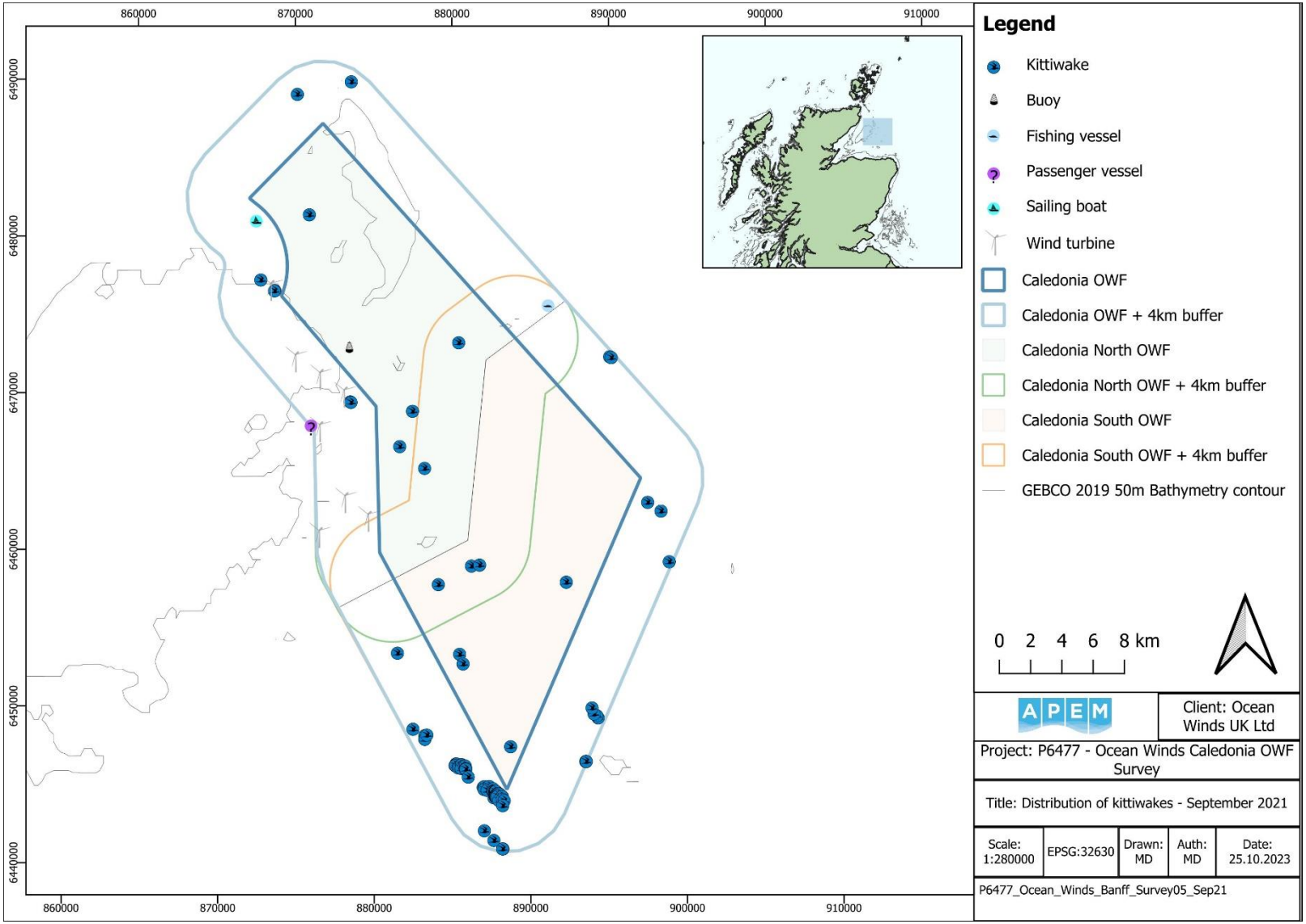



**Figure A4.50 Distribution of kittiwakes recorded in the Survey Area in September 2021**

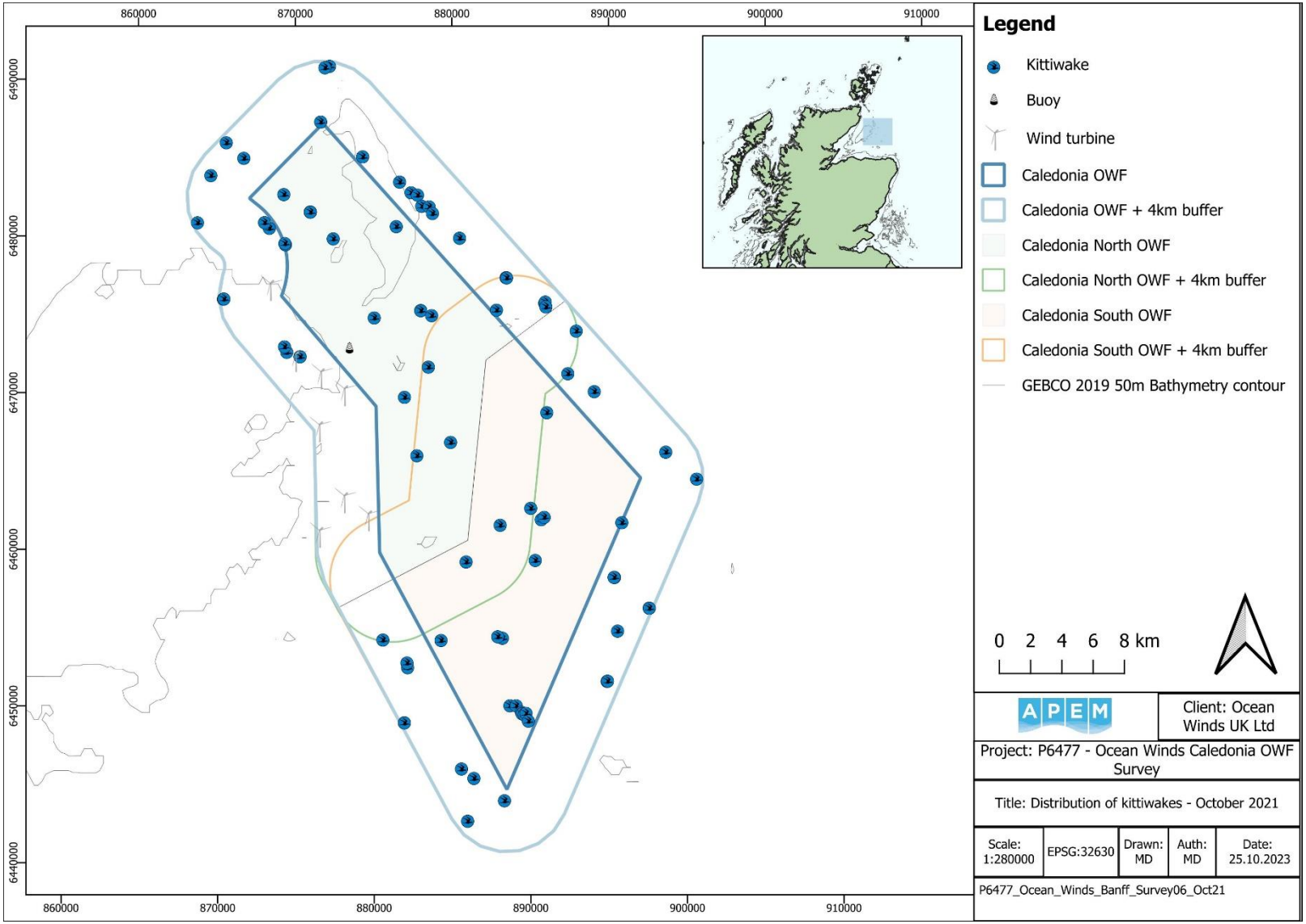



**Figure A4.51 Distribution of kittiwakes recorded in the Survey Area in October 2021**

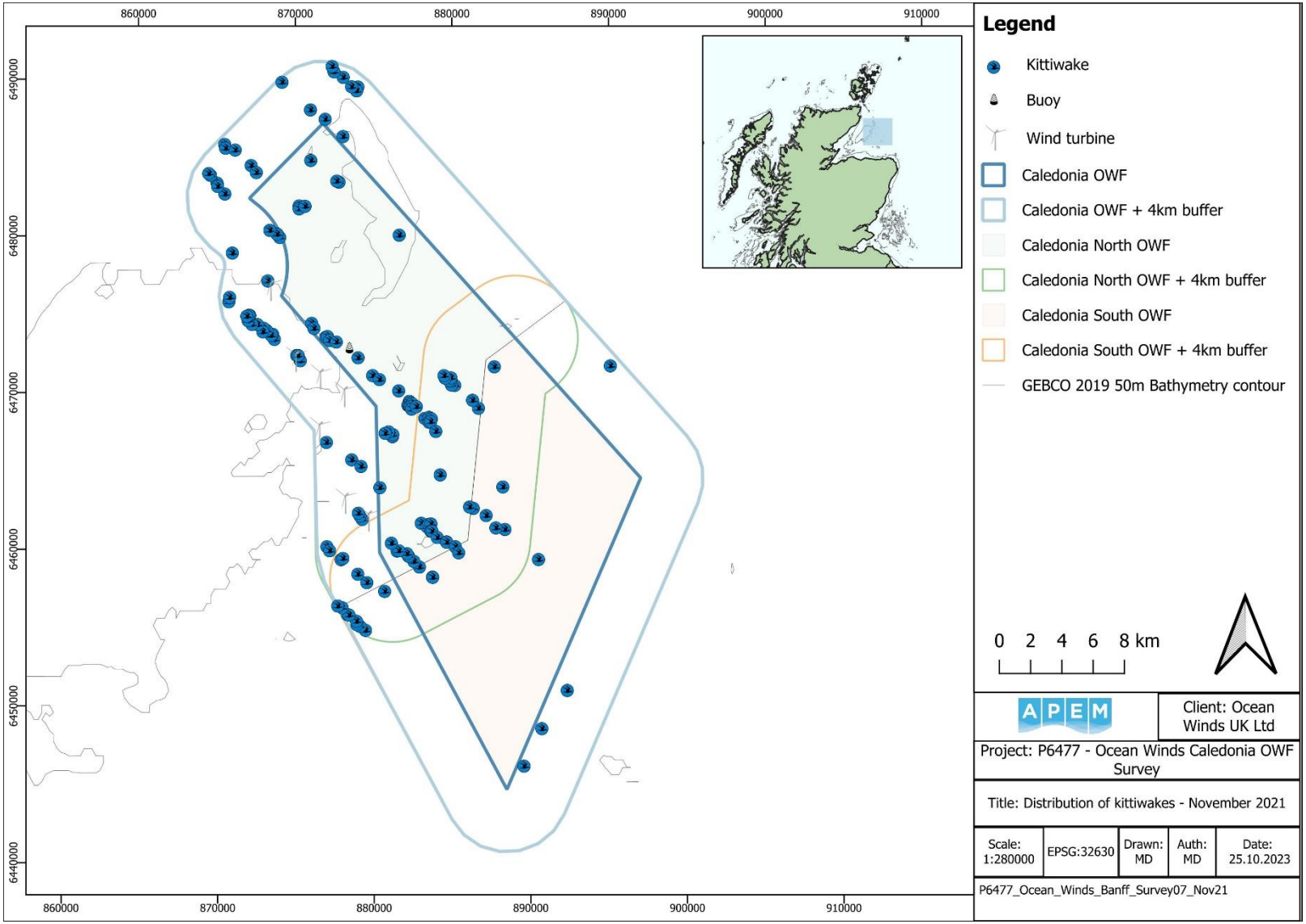



**Figure A4.52 Distribution of kittiwakes recorded in the Survey Area in November 2021**

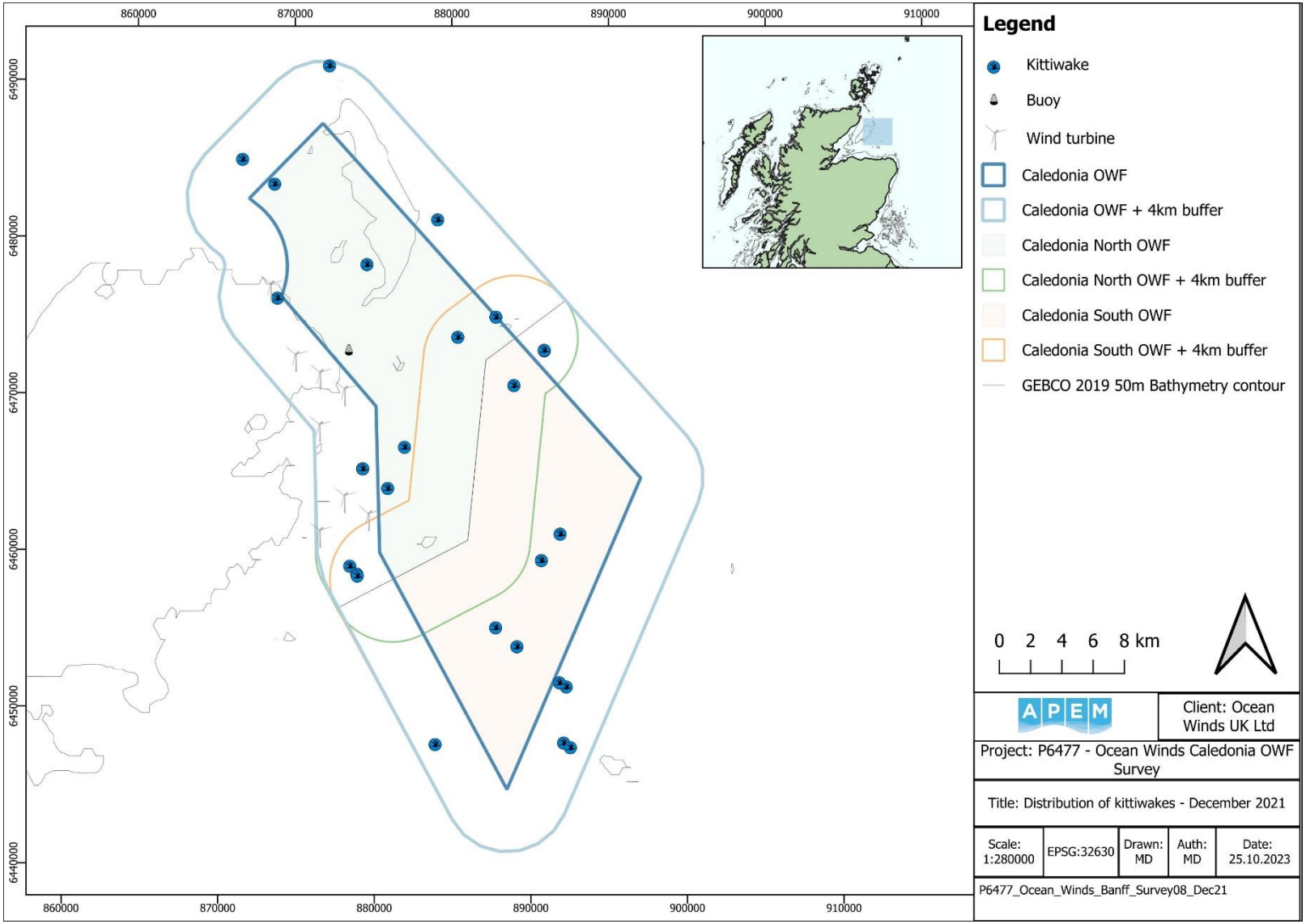



**Figure A4.53 Distribution of kittiwakes recorded in the Survey Area in December 2021**

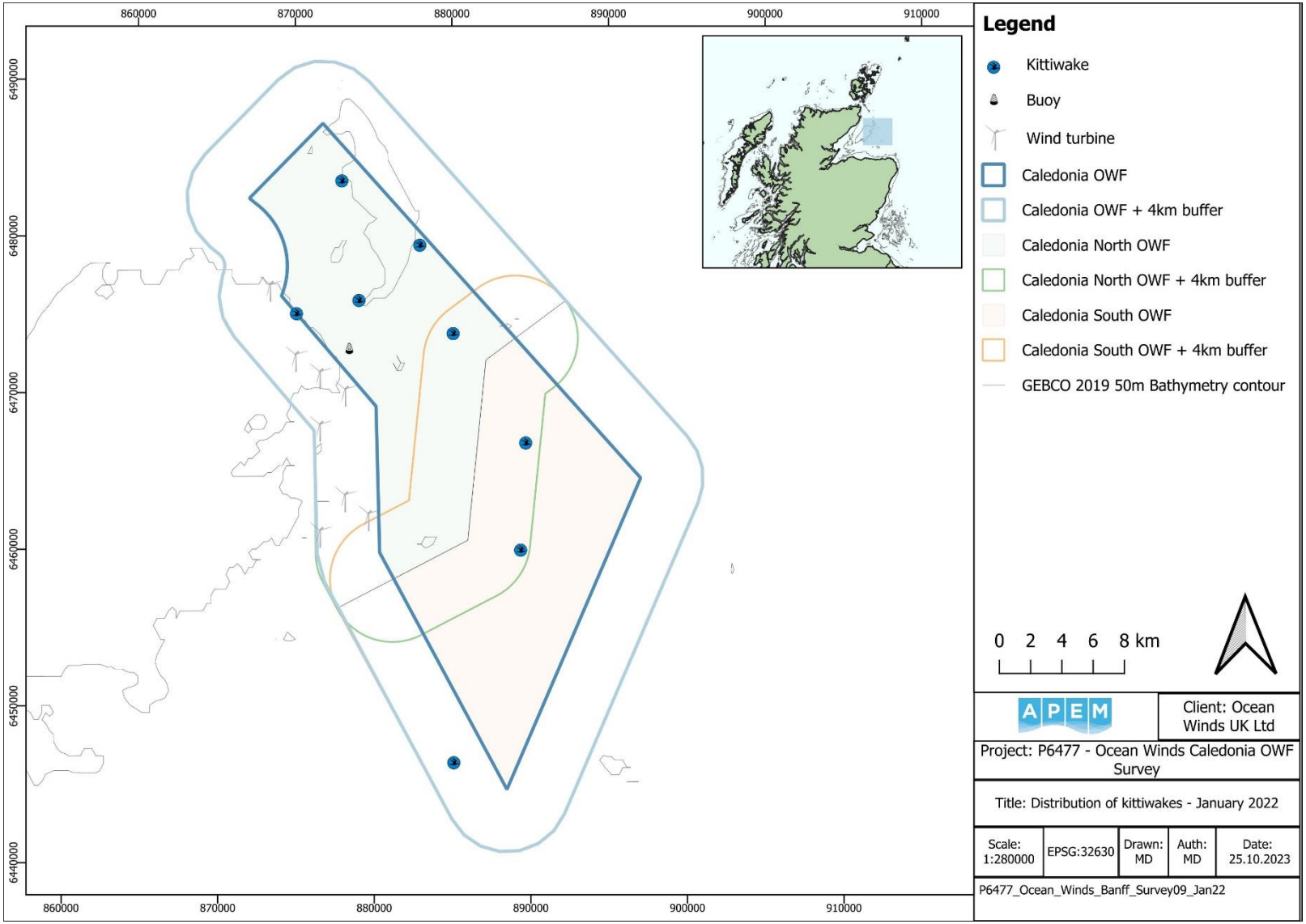



**Figure A4.54 Distribution of kittiwakes recorded in the Survey Area in January 2022**

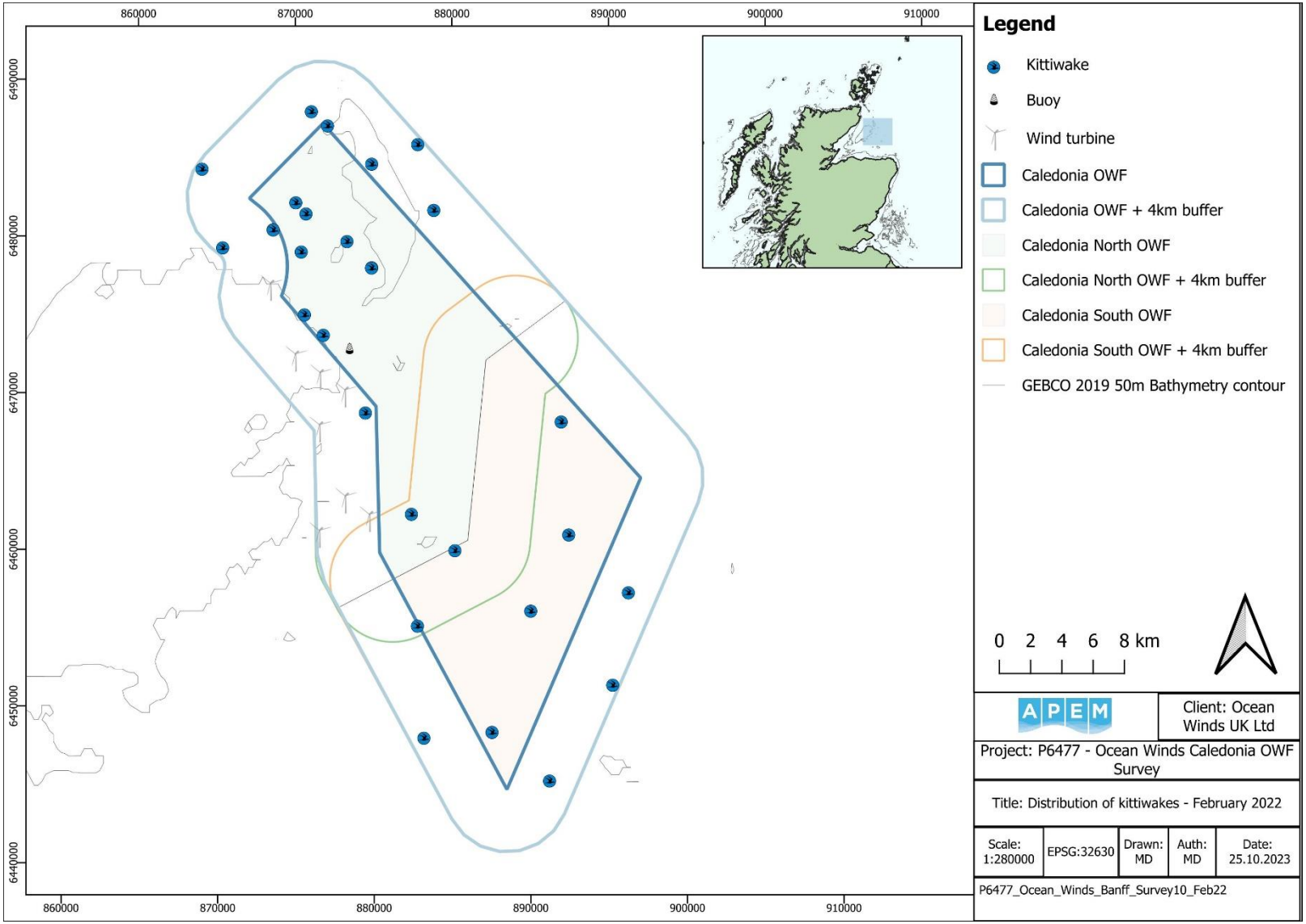



**Figure A4.55 Distribution of kittiwakes recorded in the Survey Area in February 2022**

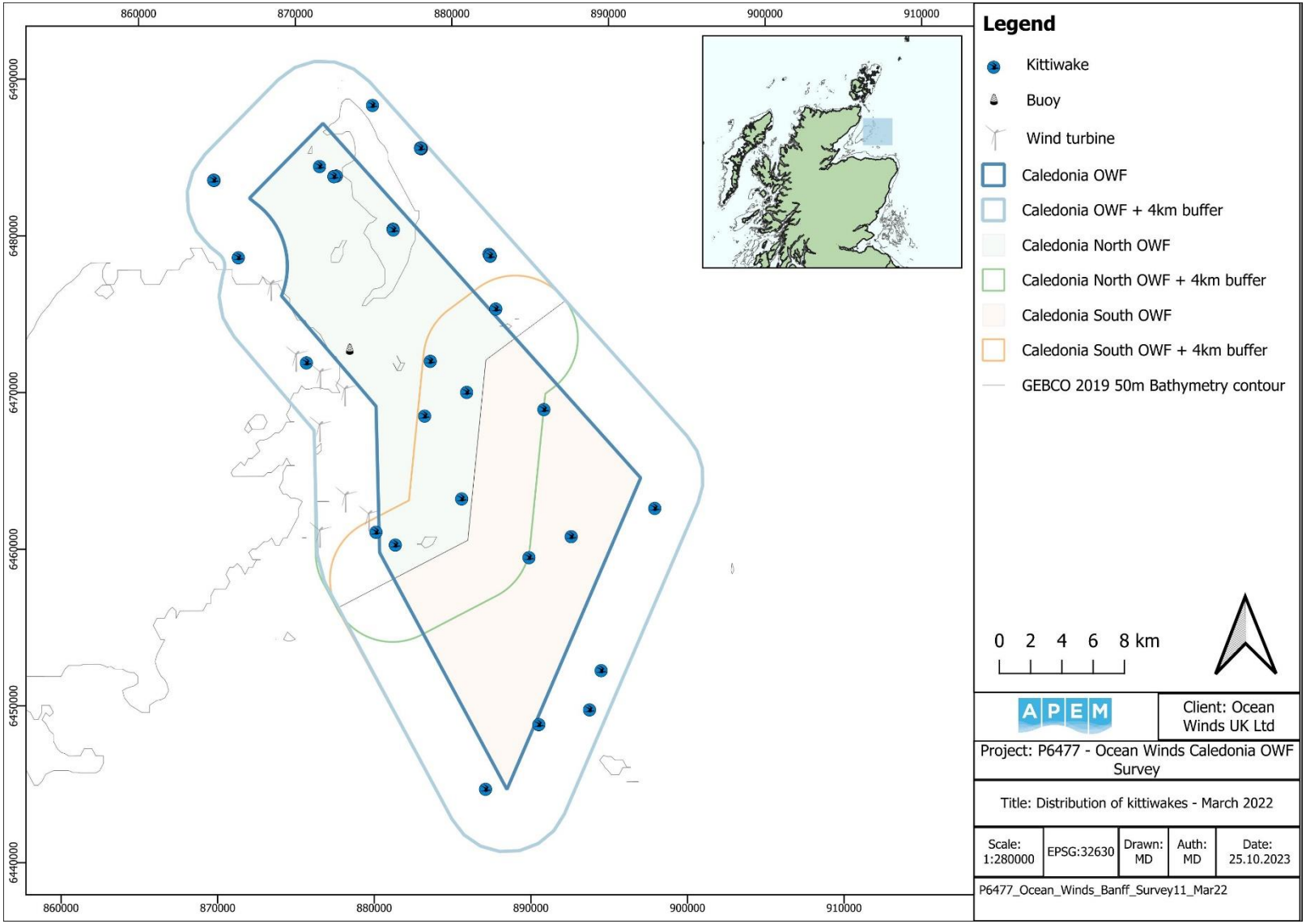



**Figure A4.56 Distribution of kittiwakes recorded in the Survey Area in March 2022**

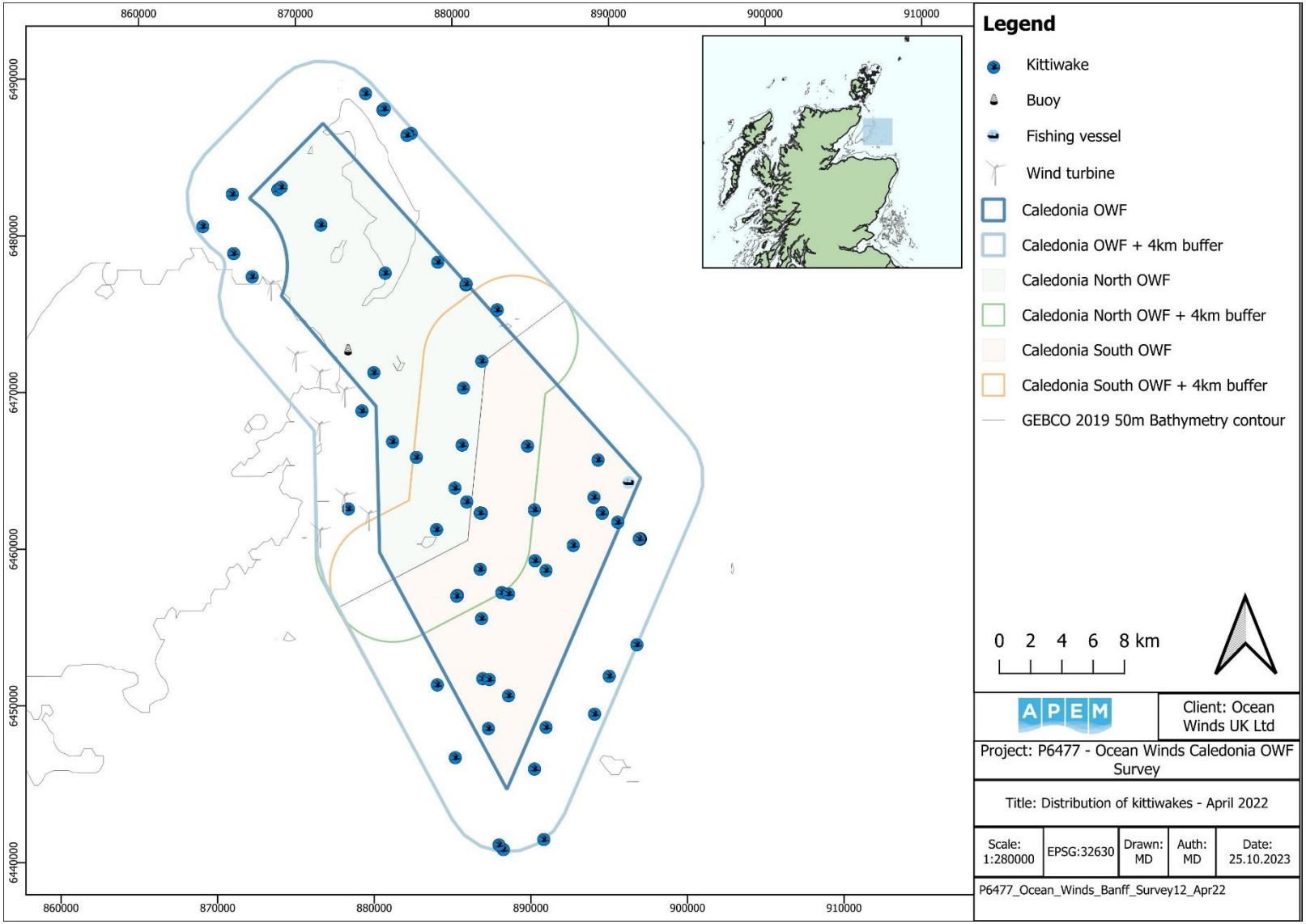



**Figure A4.57 Distribution of kittiwakes recorded in the Survey Area in April 2022**

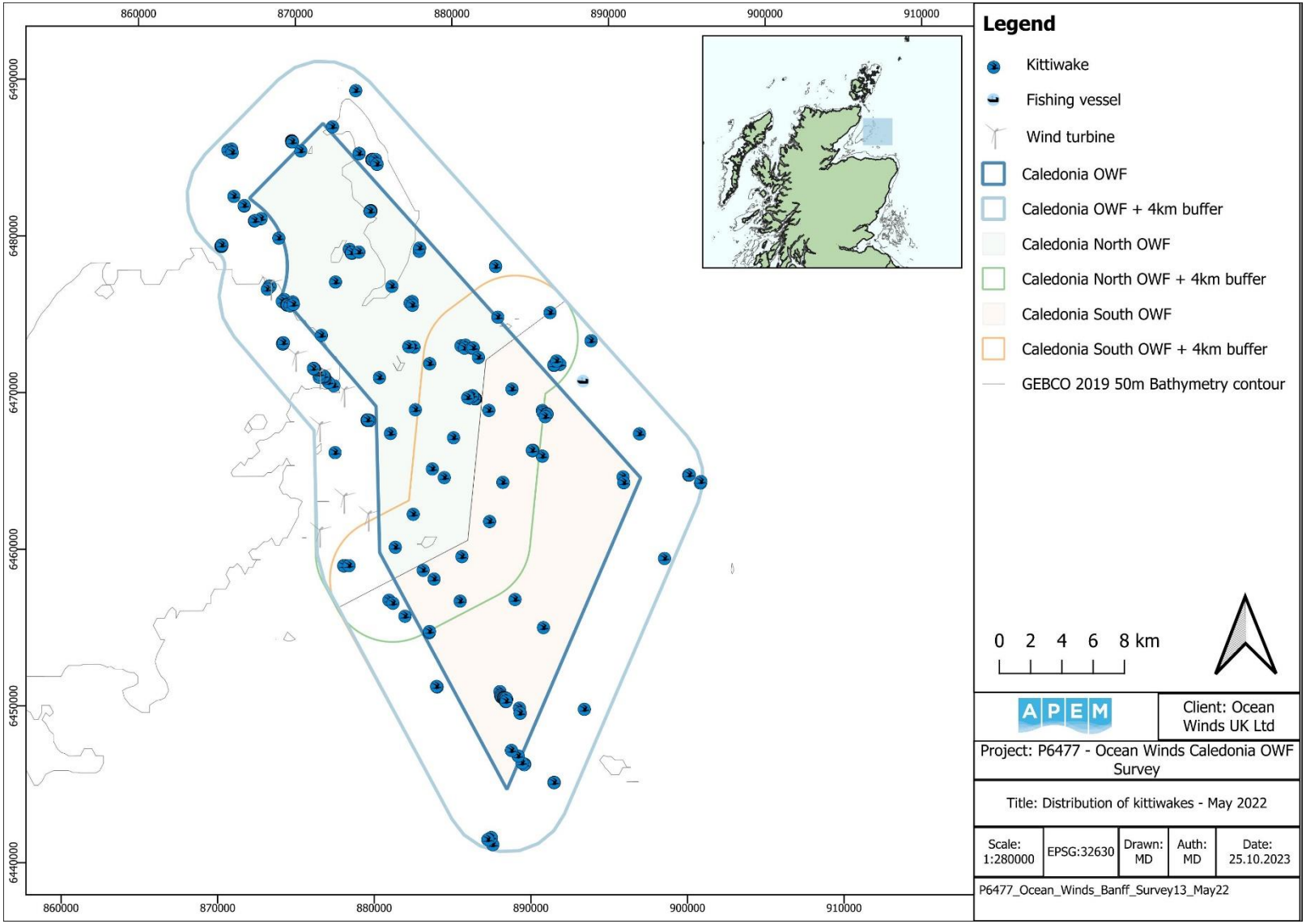



**Figure A4.58 Distribution of kittiwakes recorded in the Survey Area in May 2022**

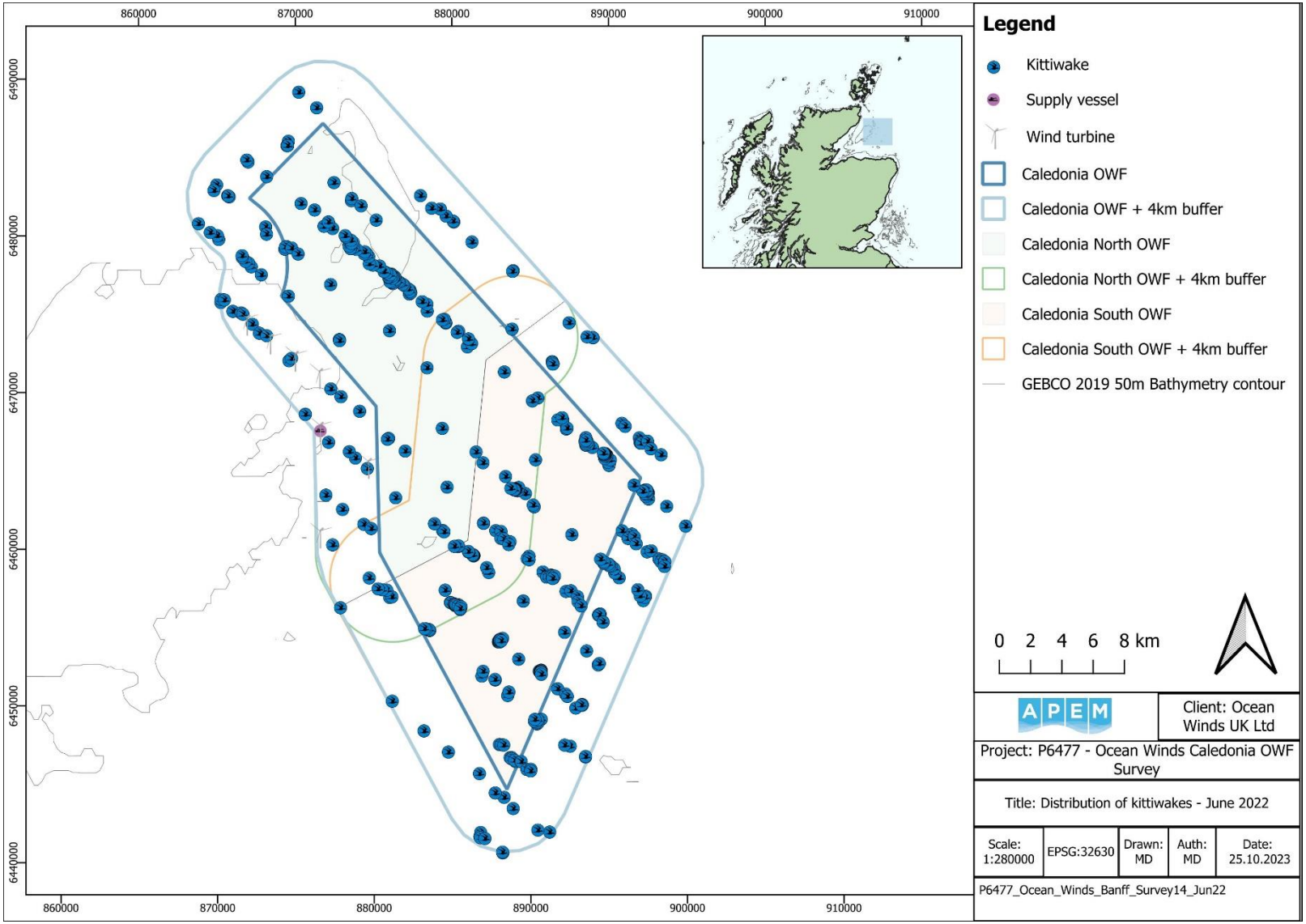



**Figure A4.59 Distribution of kittiwakes recorded in the Survey Area in June 2022**

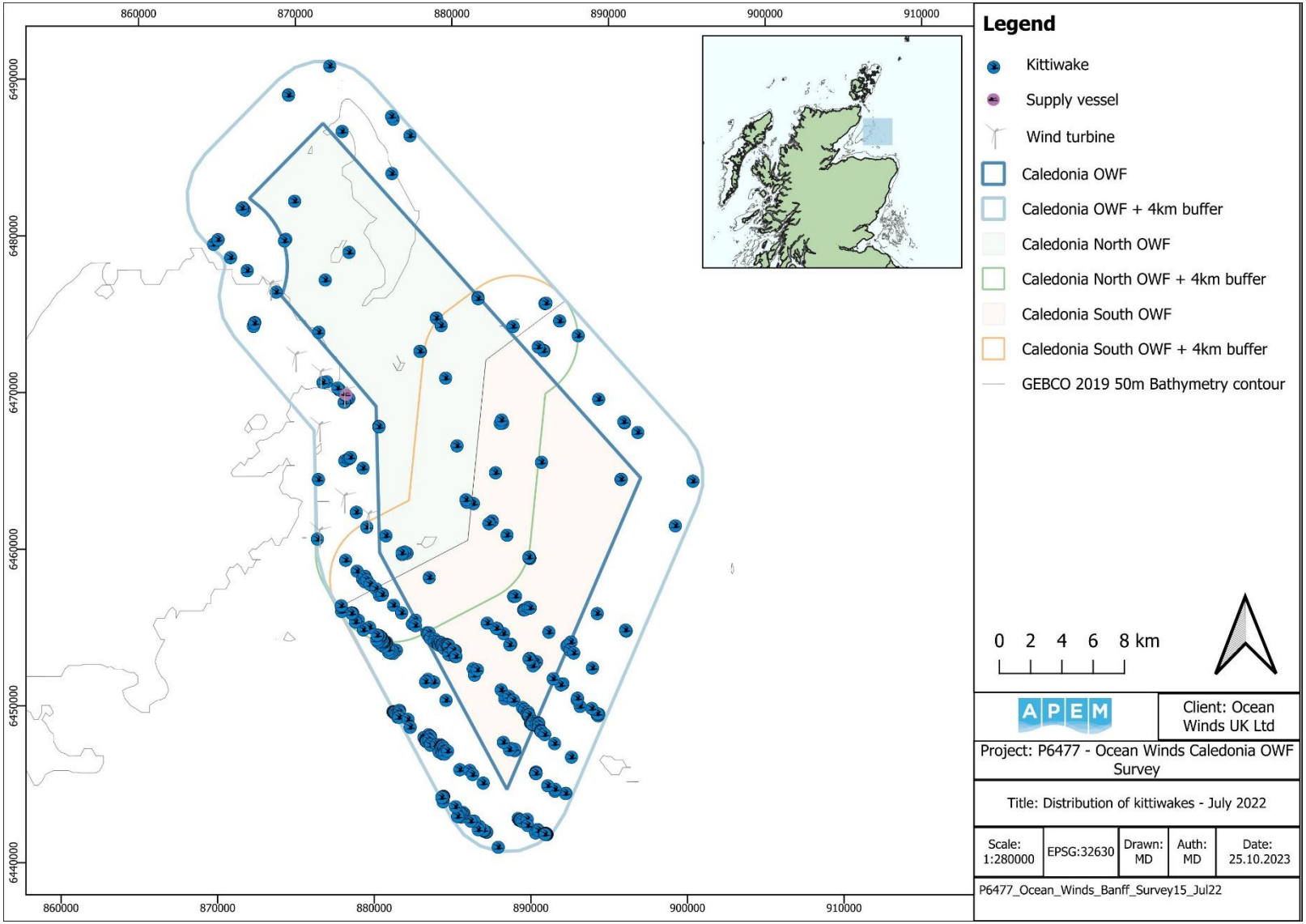



**Figure A4.60 Distribution of kittiwakes recorded in the Survey Area in July 2022**

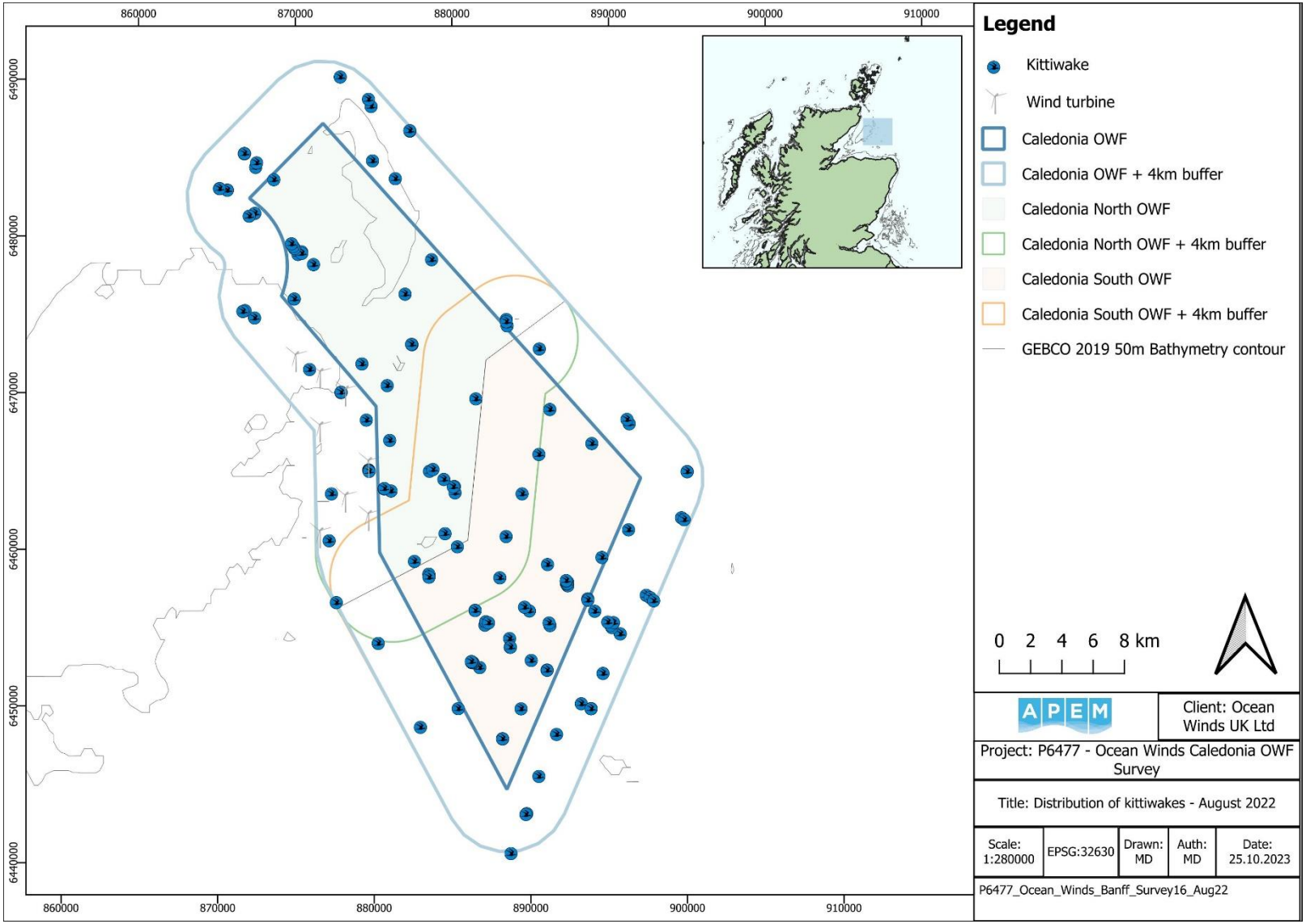



**Figure A4.61 Distribution of kittiwakes recorded in the Survey Area in August 2022**

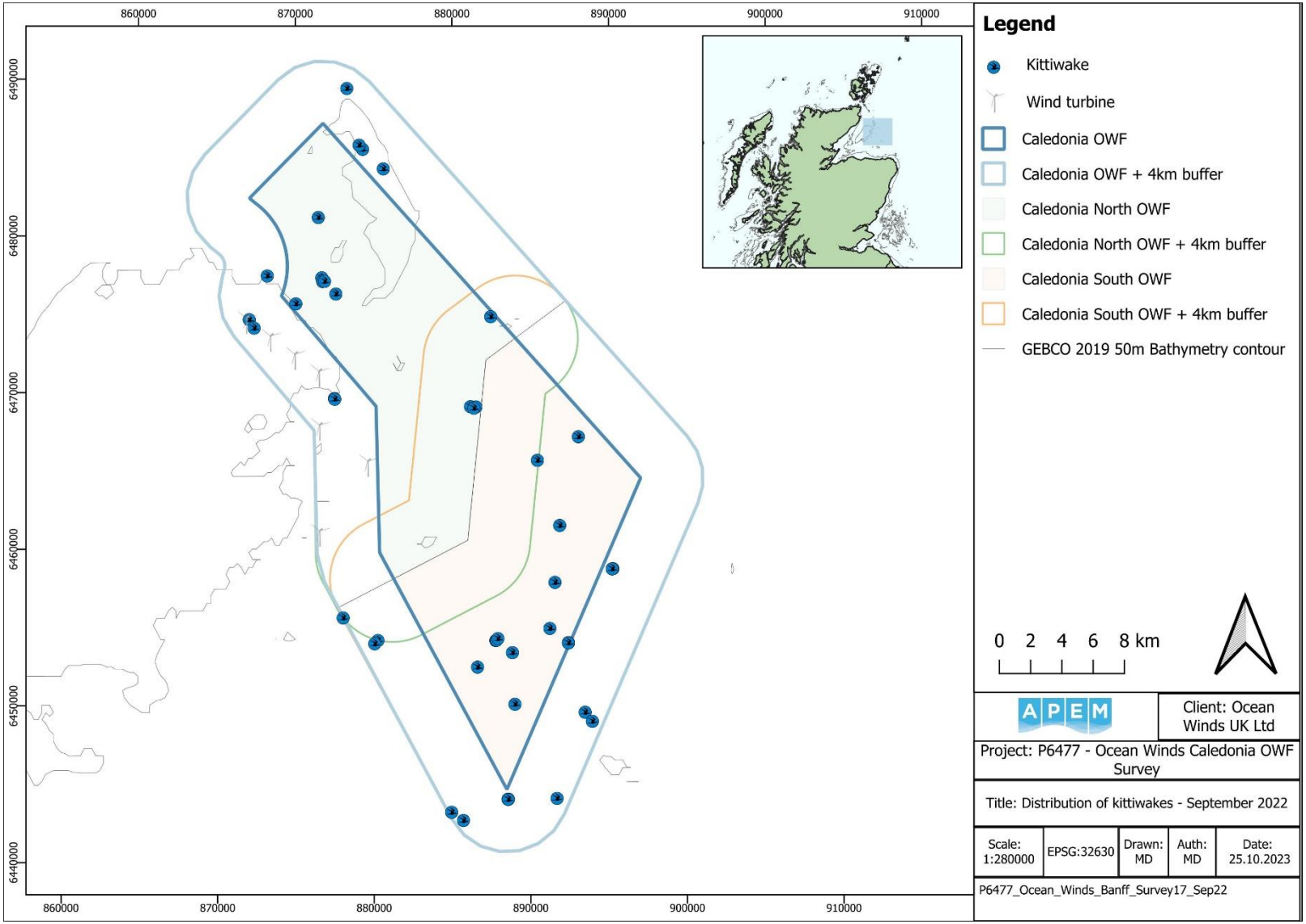



**Figure A4.62 Distribution of kittiwakes recorded in the Survey Area in September 2022**

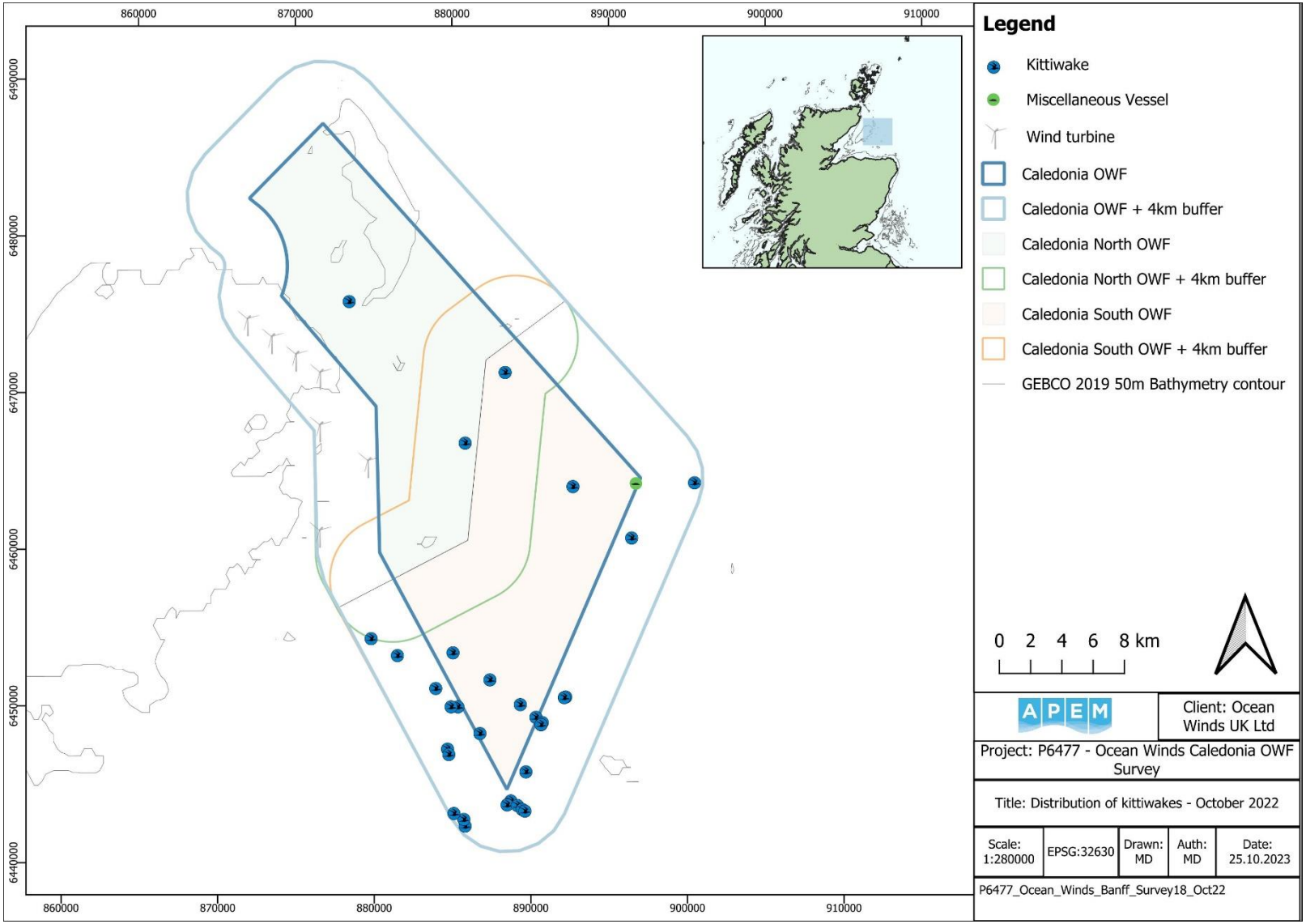



**Figure A4.63 Distribution of kittiwakes recorded in the Survey Area in October 2022**

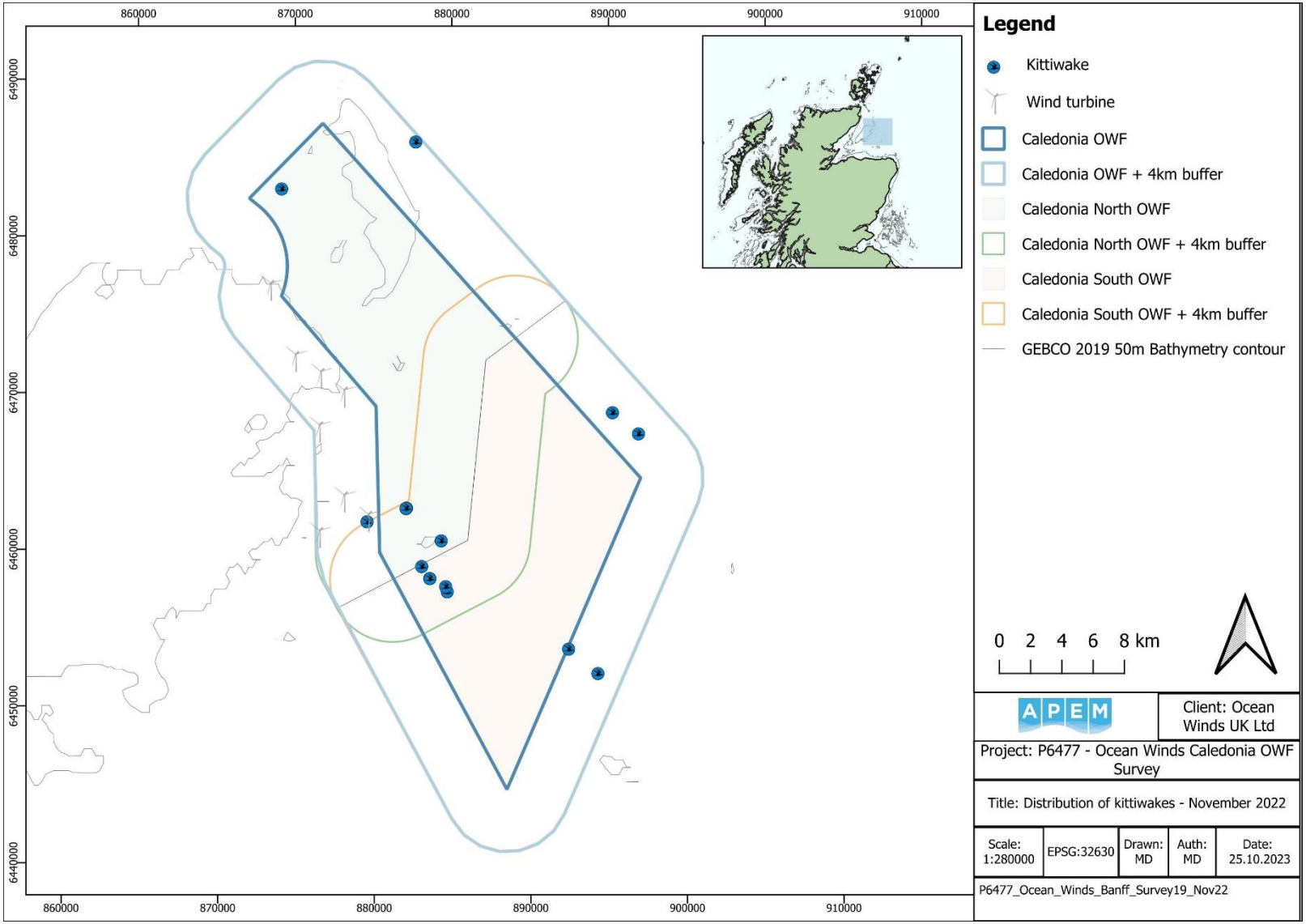



**Figure A4.64 Distribution of kittiwakes recorded in the Survey Area in November 2022**

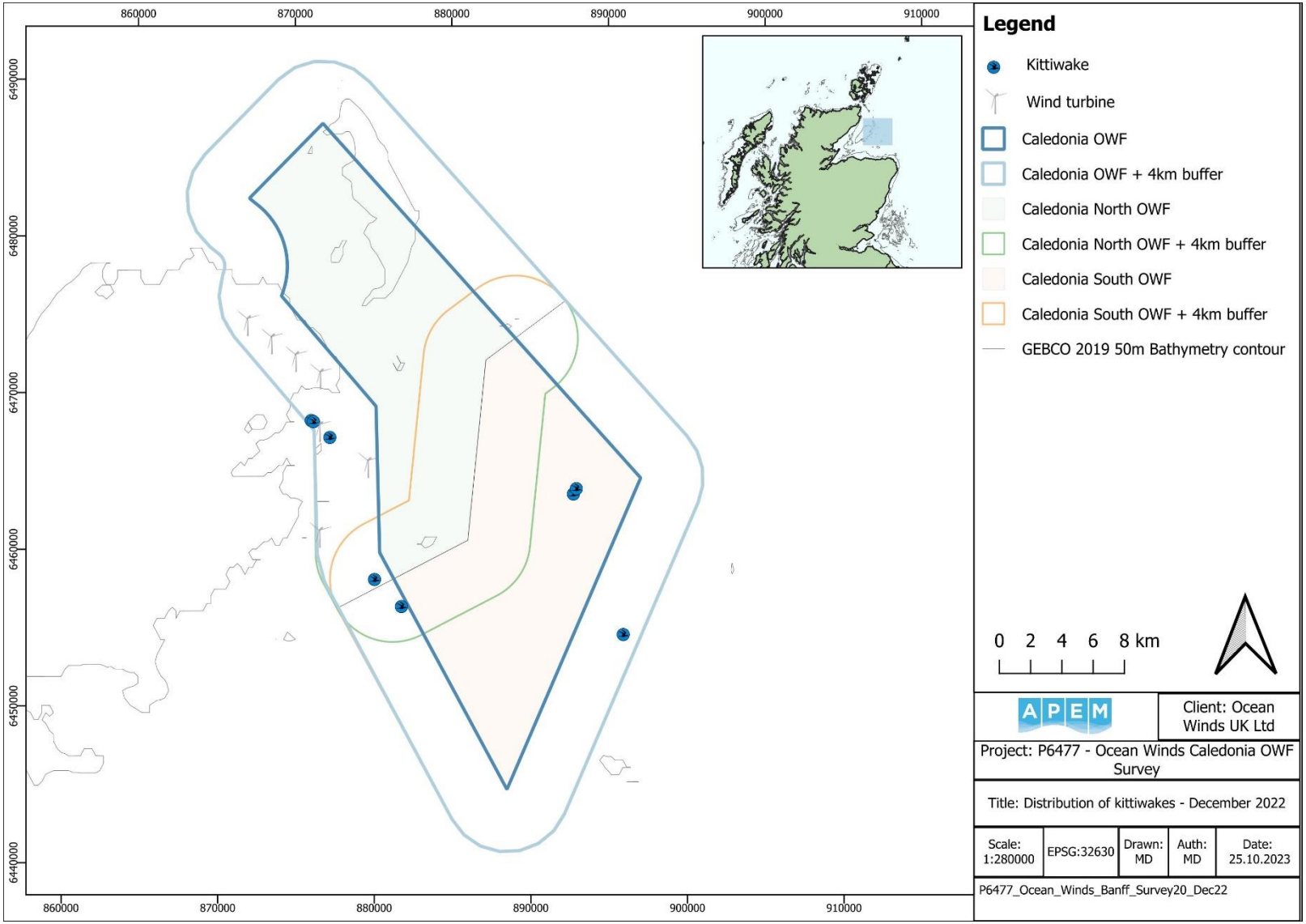



**Figure A4.65 Distribution of kittiwakes recorded in the Survey Area in December 2022**

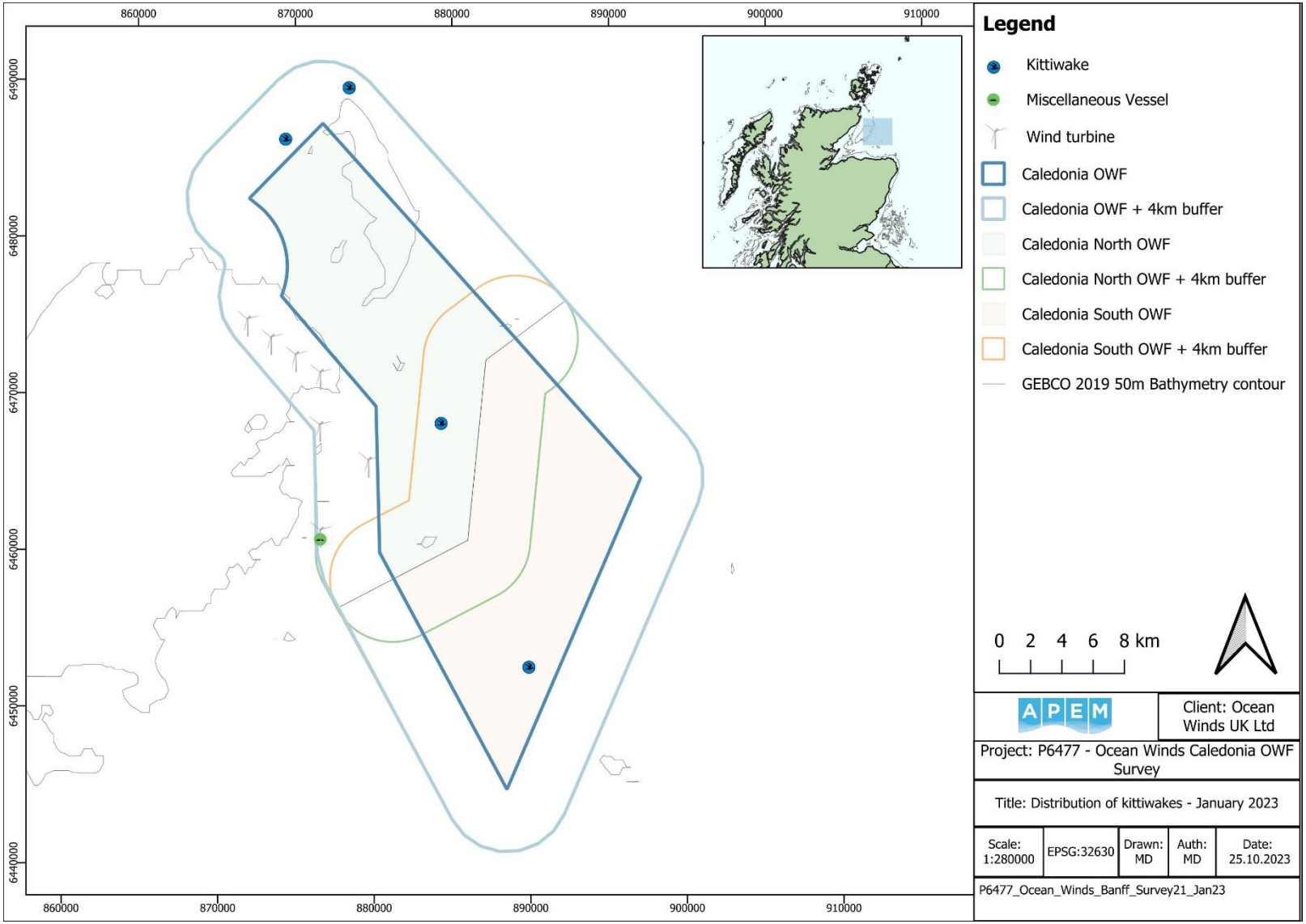



**Figure A4.66 Distribution of kittiwakes recorded in the Survey Area in January 2023**

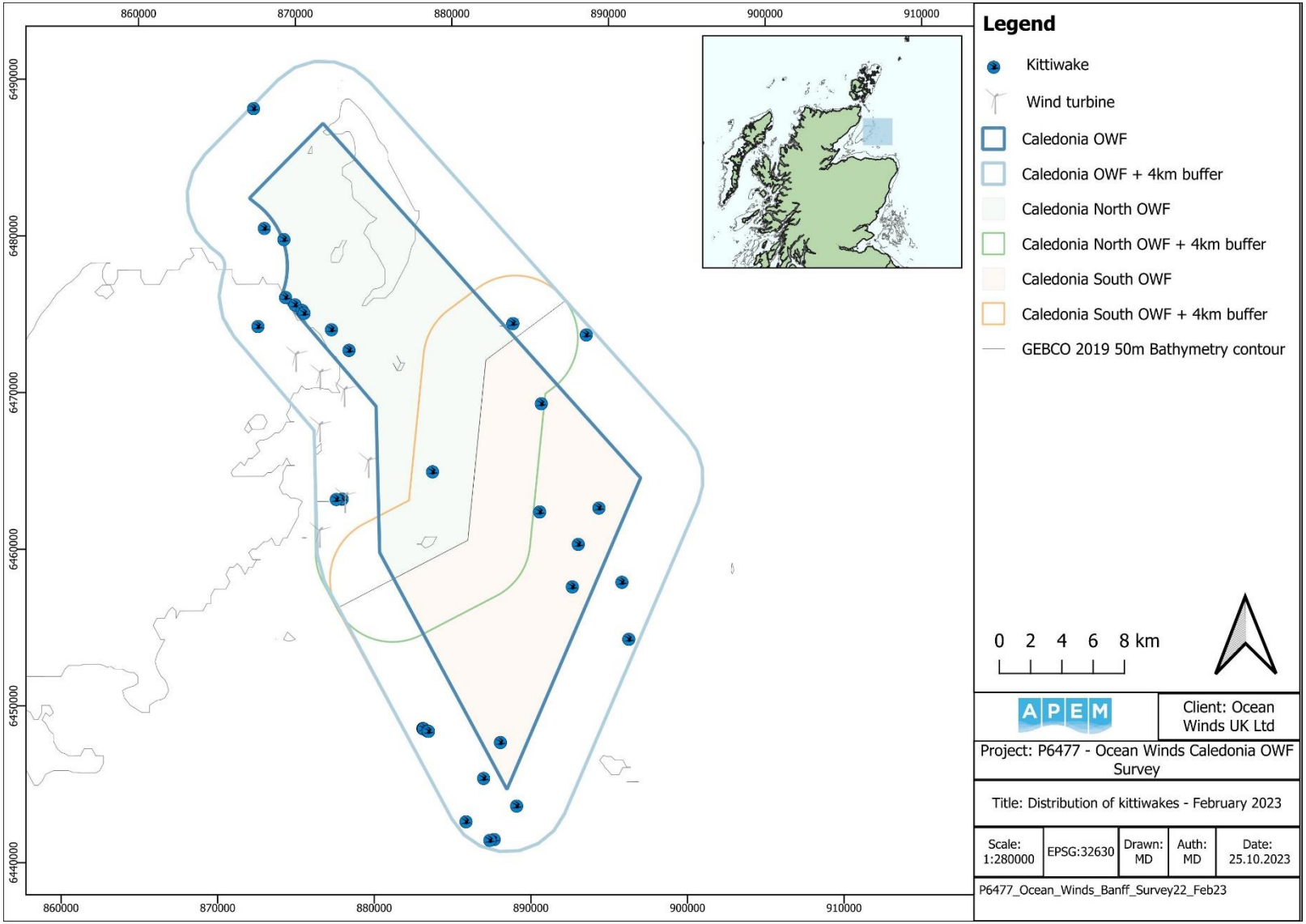



**Figure A4.67 Distribution of kittiwakes recorded in the Survey Area in February 2023**

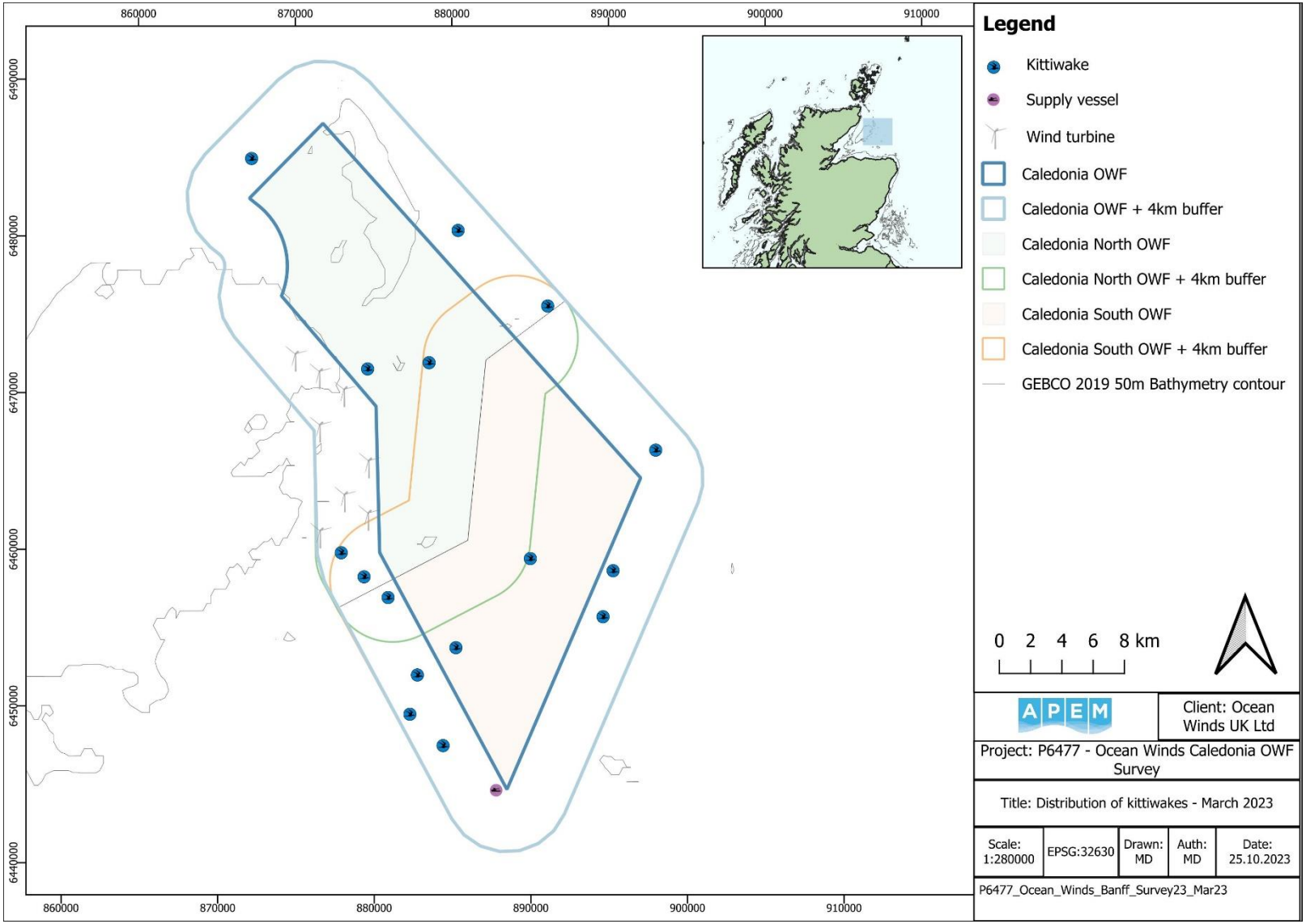



**Figure A4.68 Distribution of kittiwakes recorded in the Survey Area in March 2023**

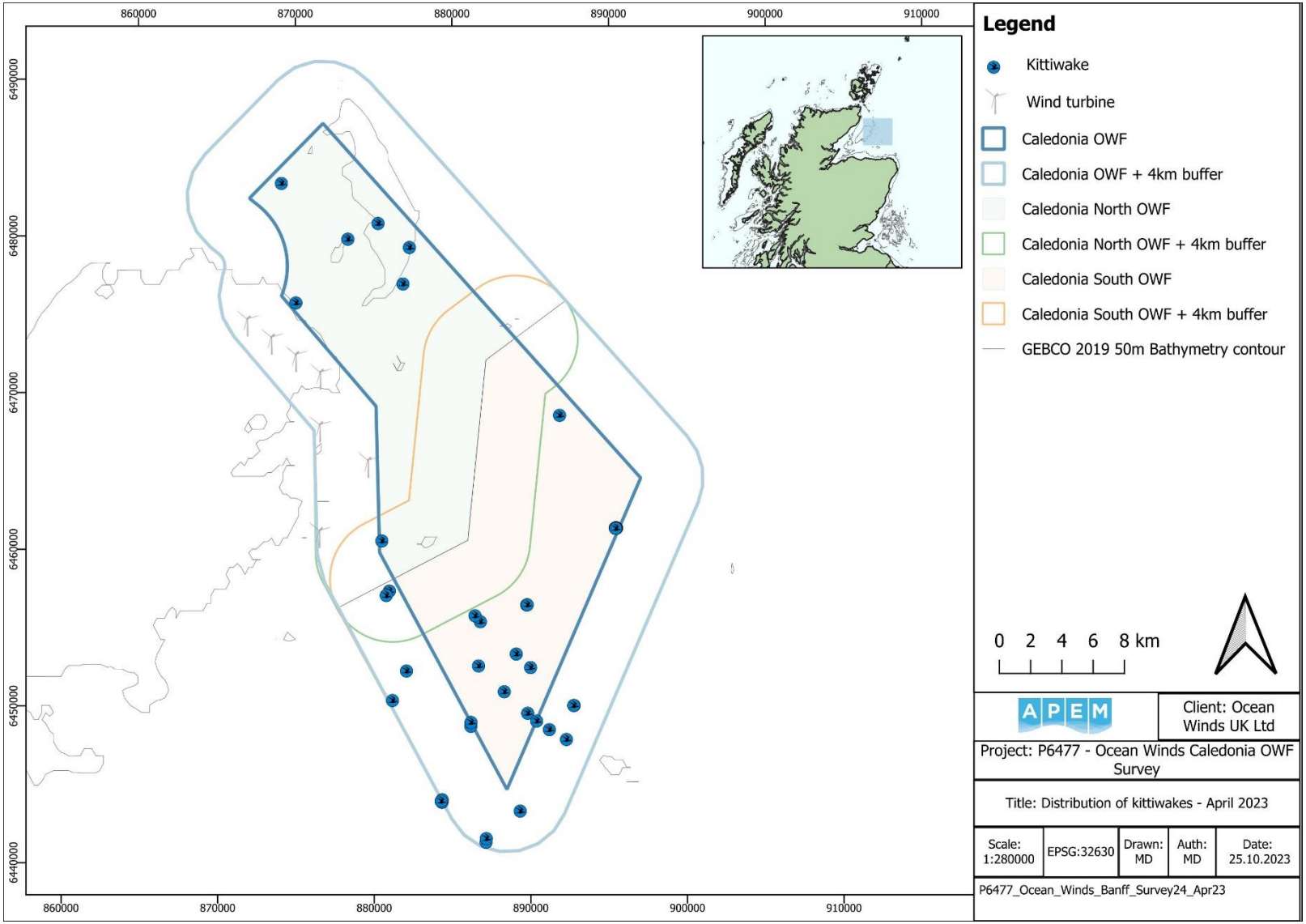



**Figure A4.69 Distribution of kittiwakes recorded in the Survey Area in April 2023**

## Common gull

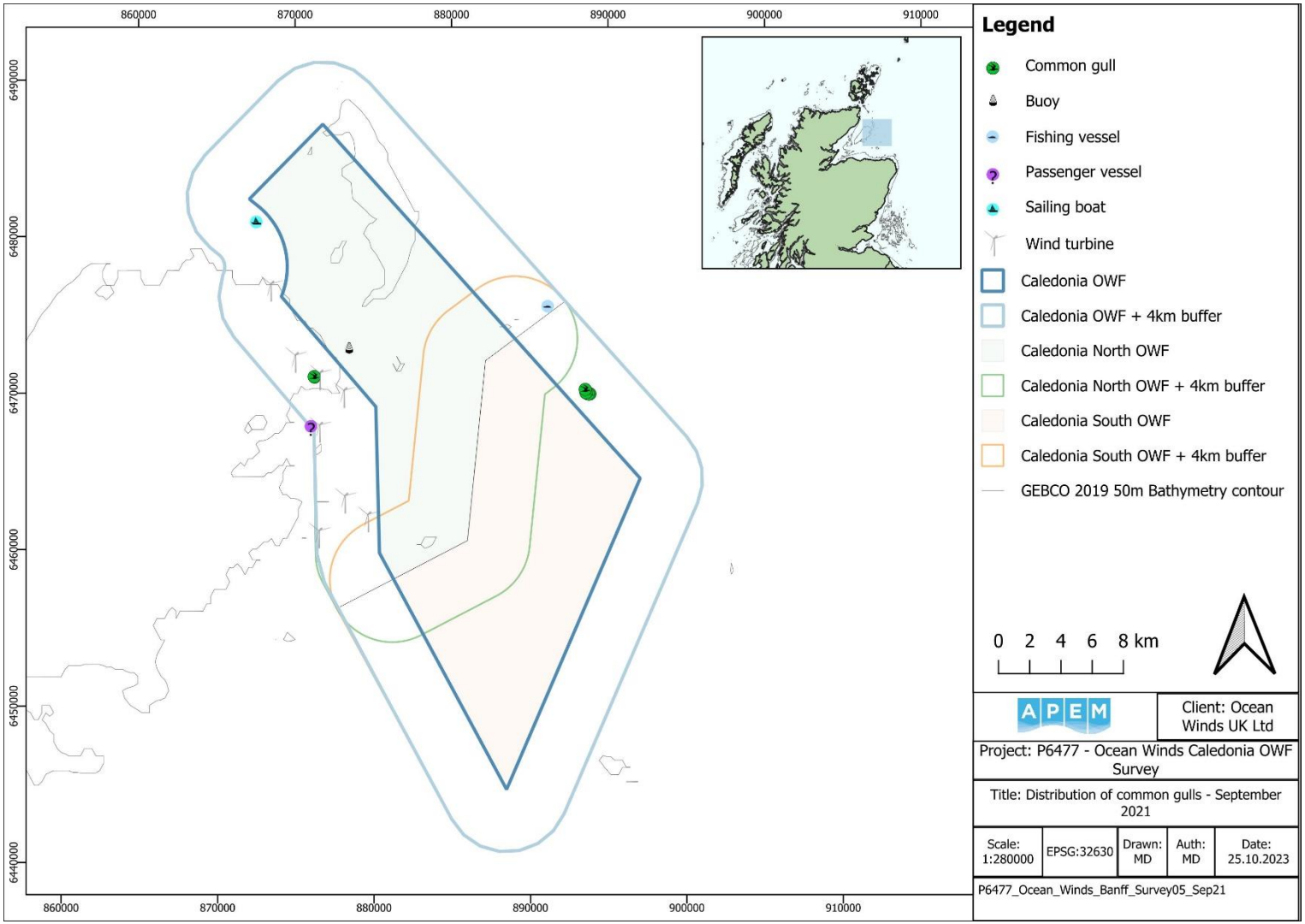



**Figure A4.70 Distribution of common gulls recorded in the Survey Area in September 2021**

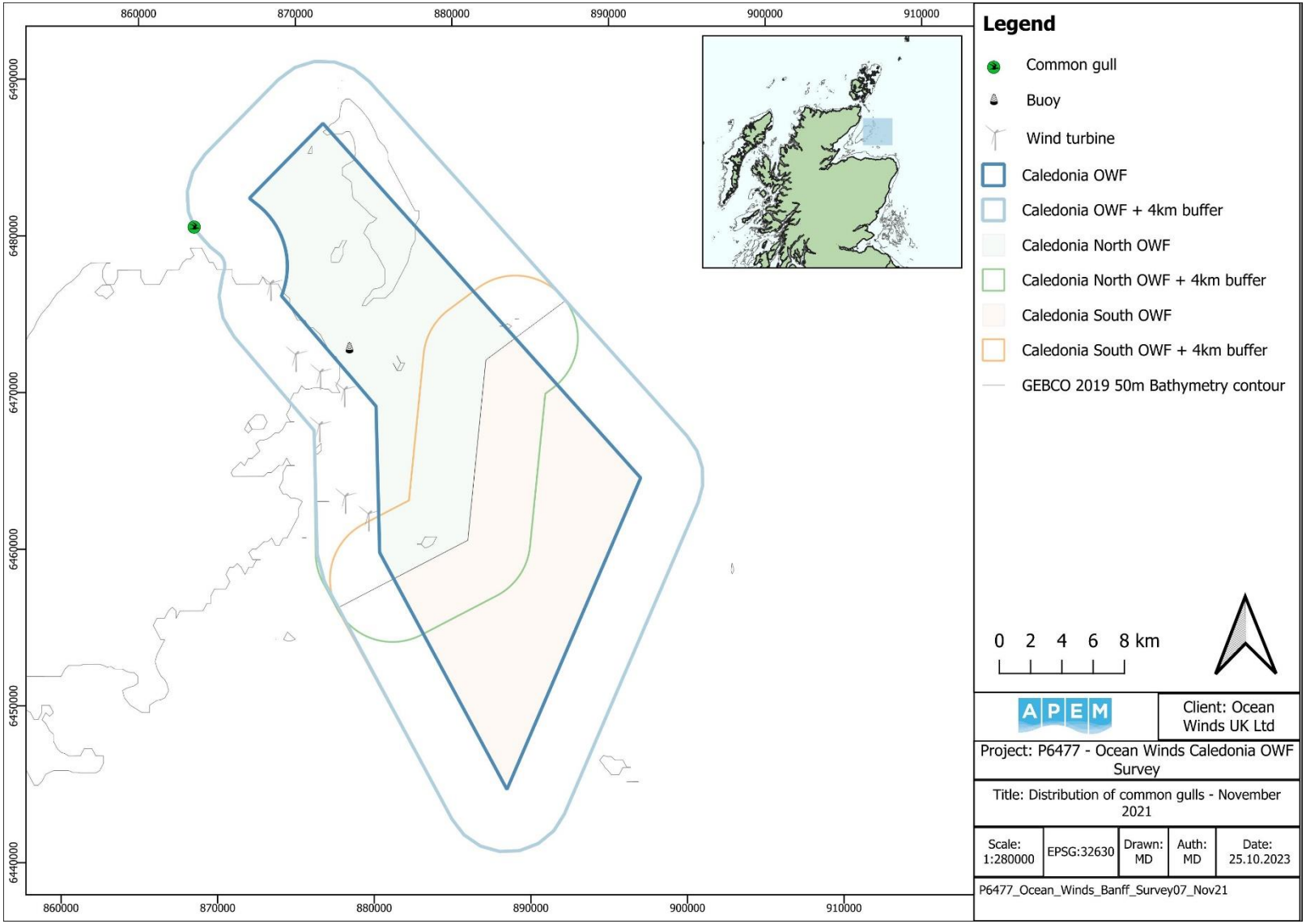



**Figure A4.71 Distribution of common gulls recorded in the Survey Area in November 2021**

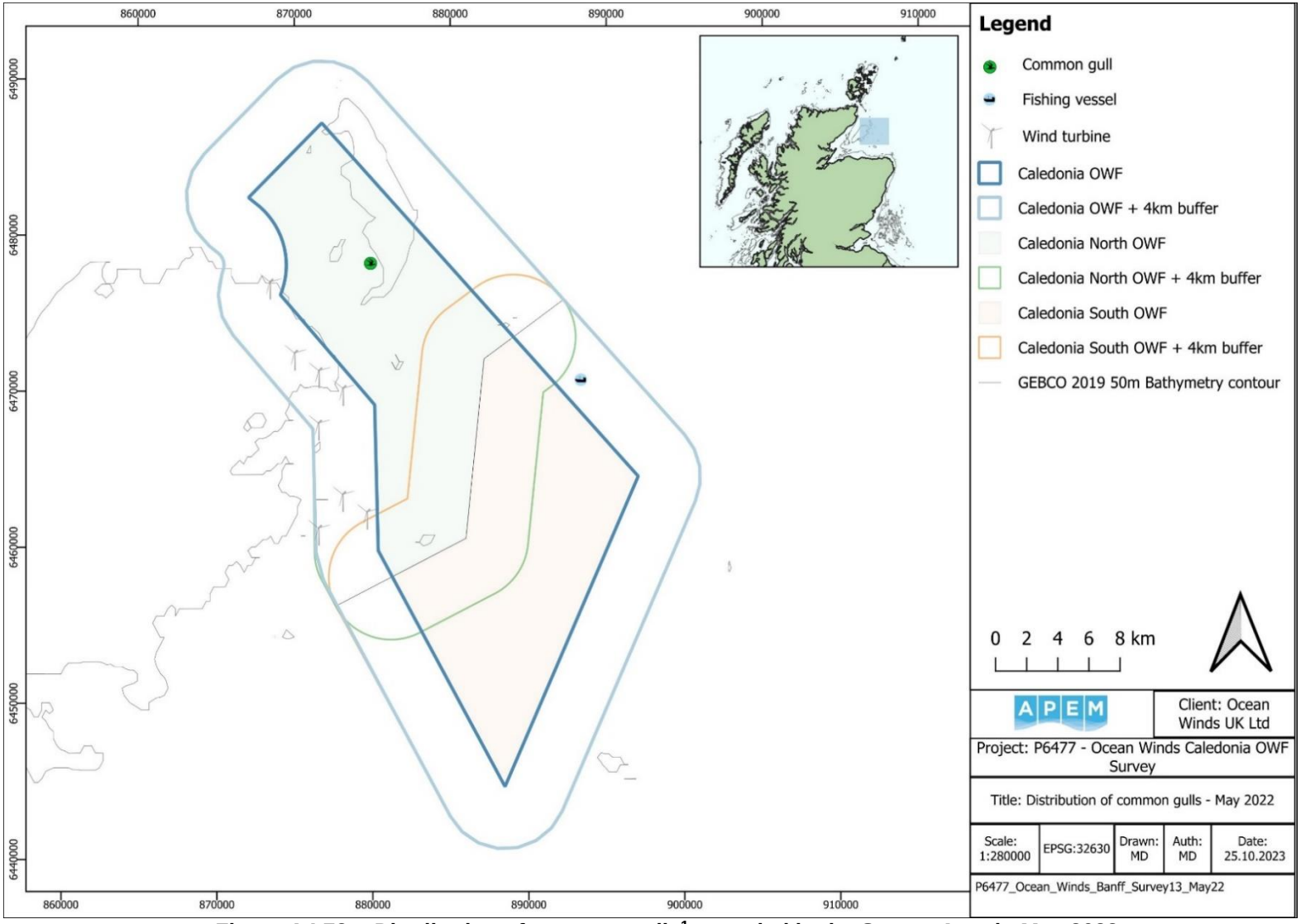



**Figure A4.72 Distribution of common gulls[1] recorded in the Survey Area in May 2022**

[1]deceased individual

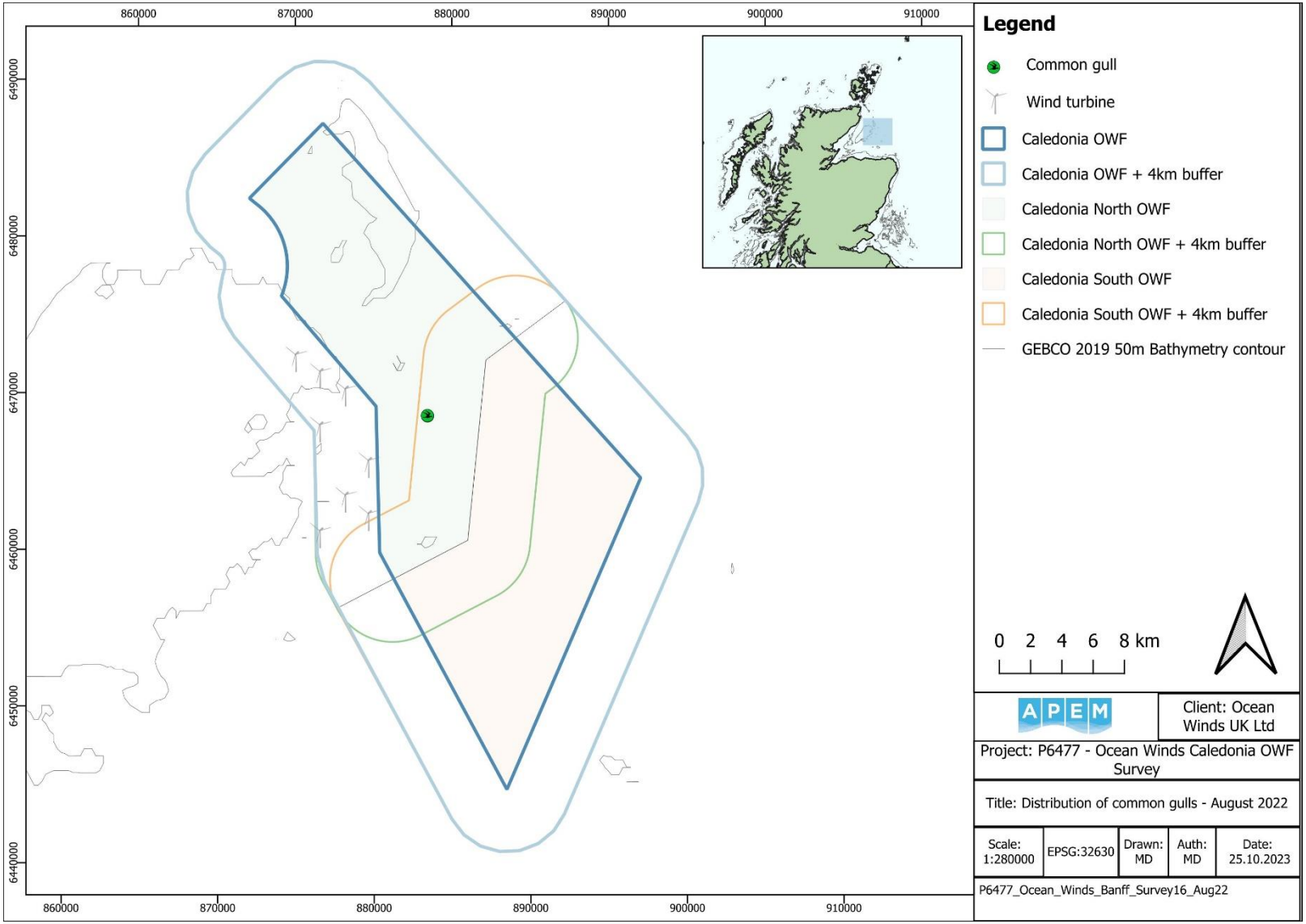



**Figure A4.73 Distribution of common gulls recorded in the Survey Area in August 2022**

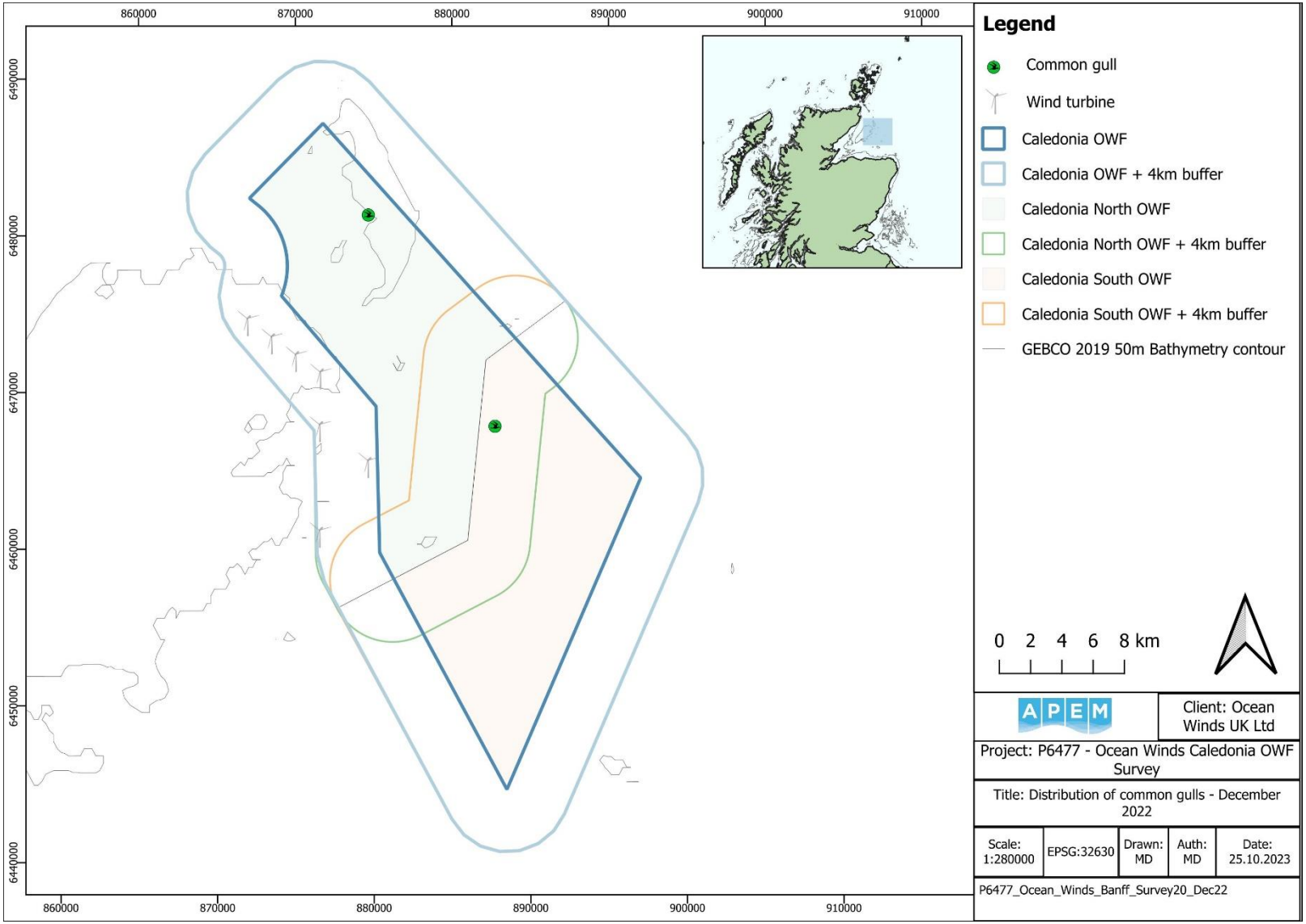



**Figure A4.74 Distribution of common gulls recorded in the Survey Area in December 2022**

## Great black-backed gull

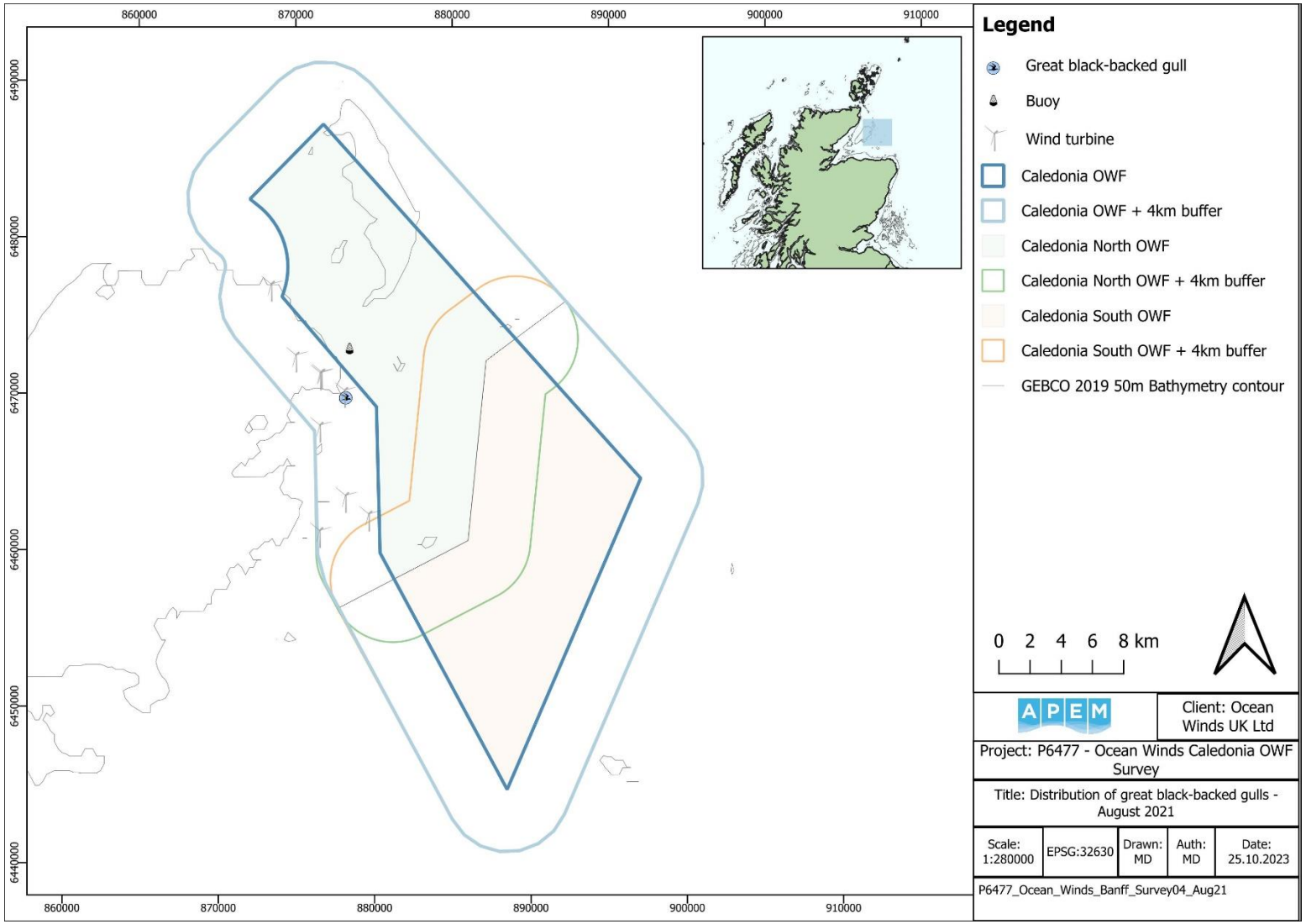



**Figure A4.75 Distribution of great black-backed gulls recorded in the Survey Area in August 2021**

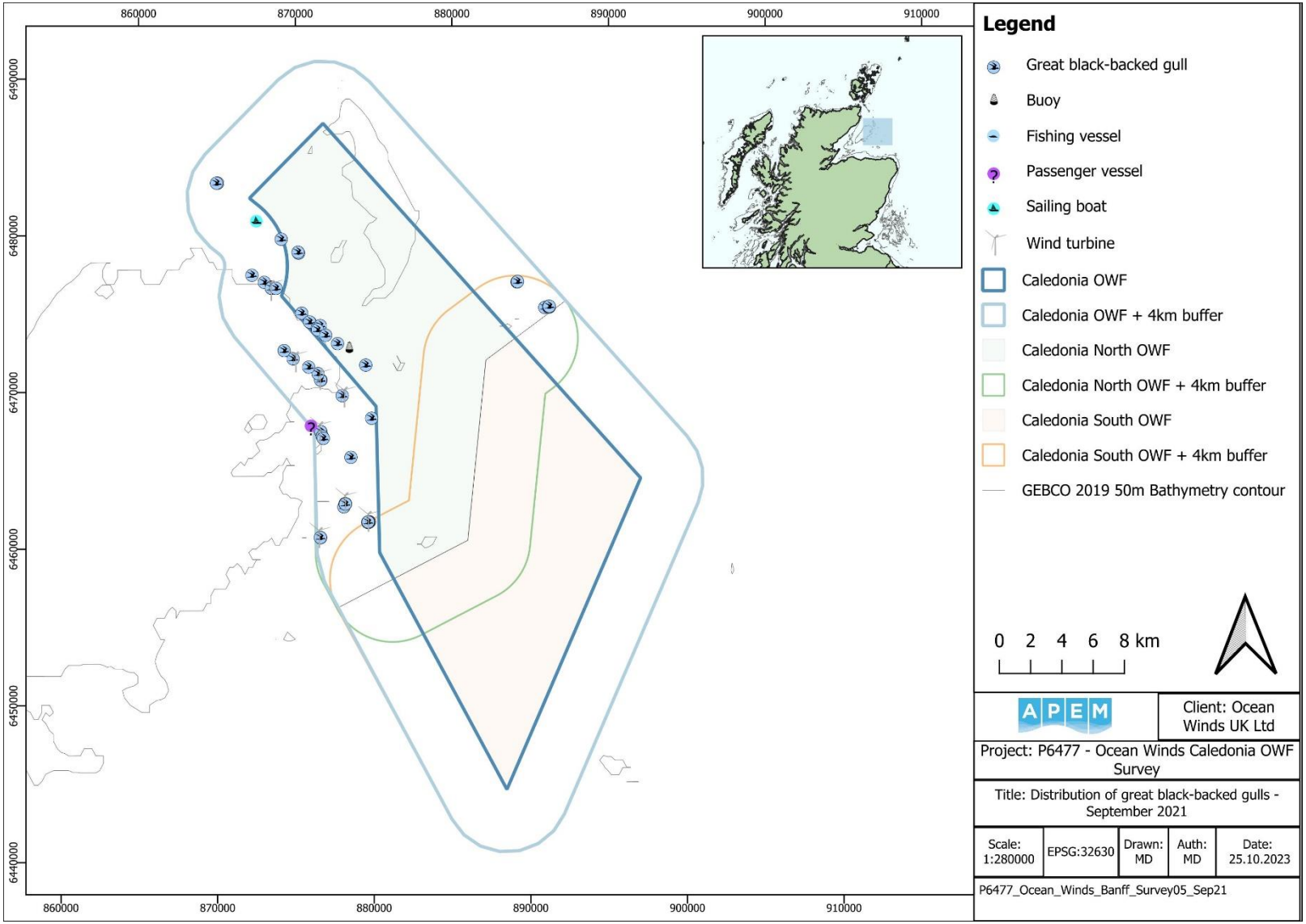



**Figure A4.76 Distribution of great black-backed gulls recorded in the Survey Area in September 2021**

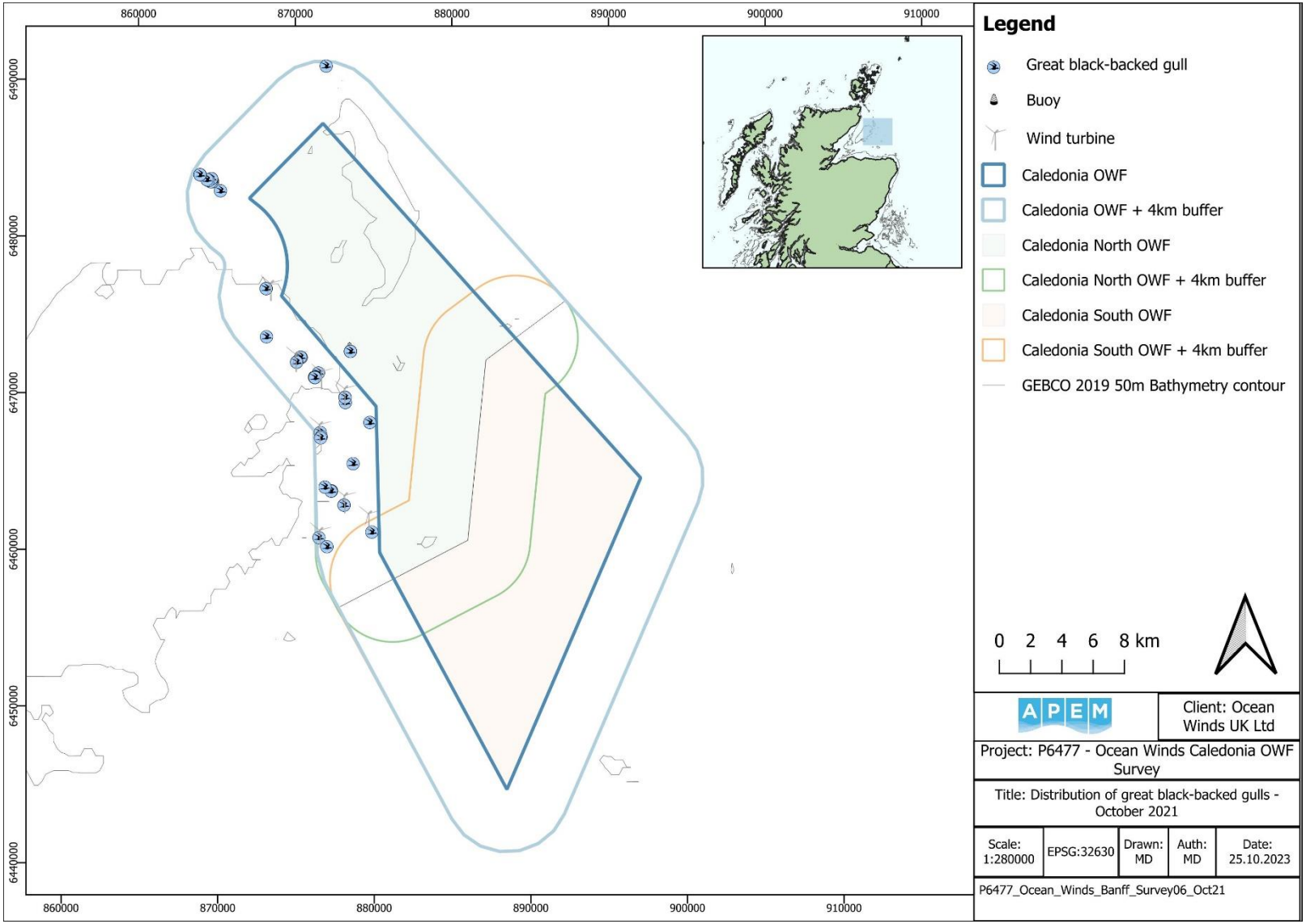



**Figure A4.77 Distribution of great black-backed gulls recorded in the Survey Area in October 2021**

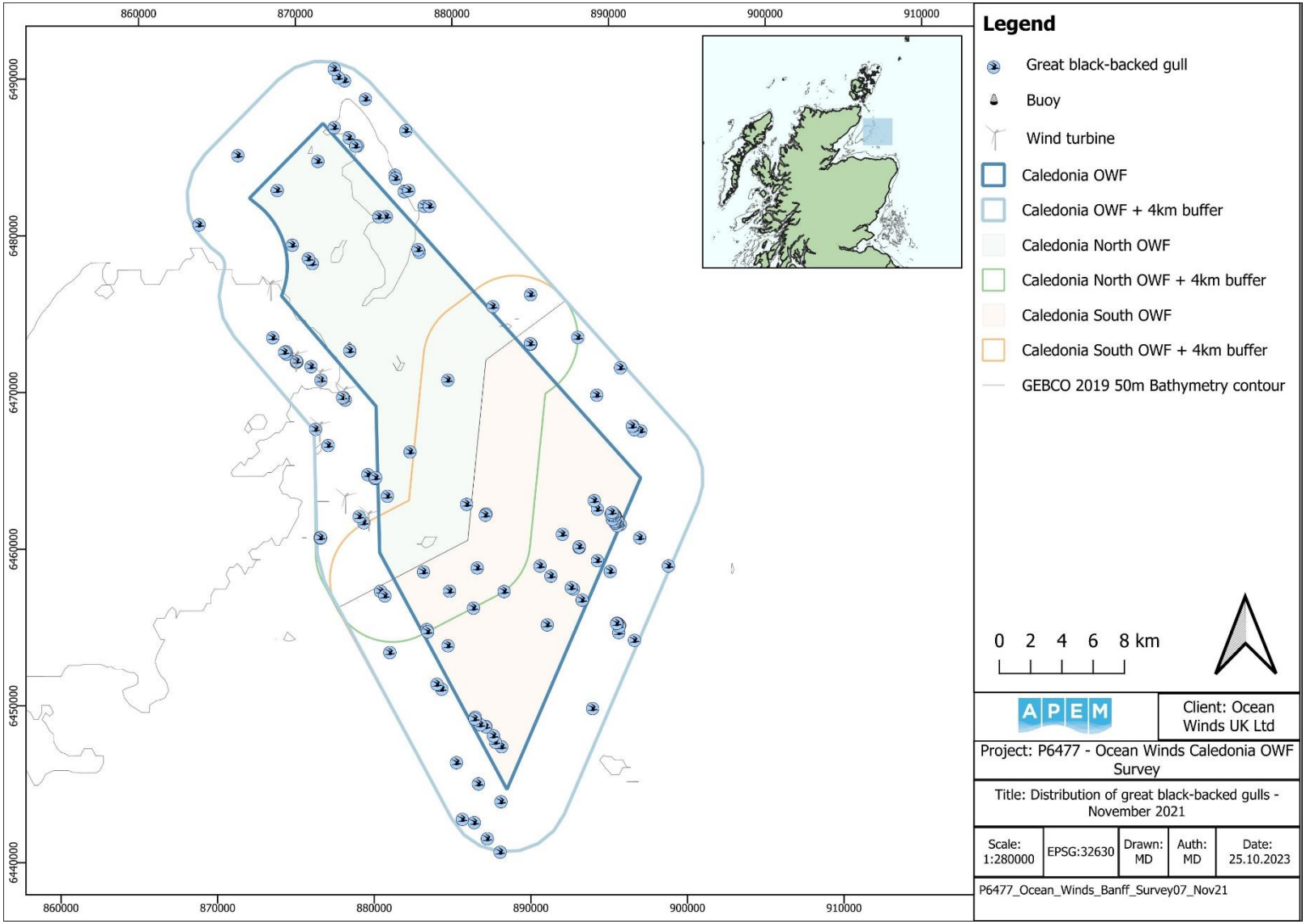



**Figure A4.78 Distribution of great black-backed gulls recorded in the Survey Area in November 2021**

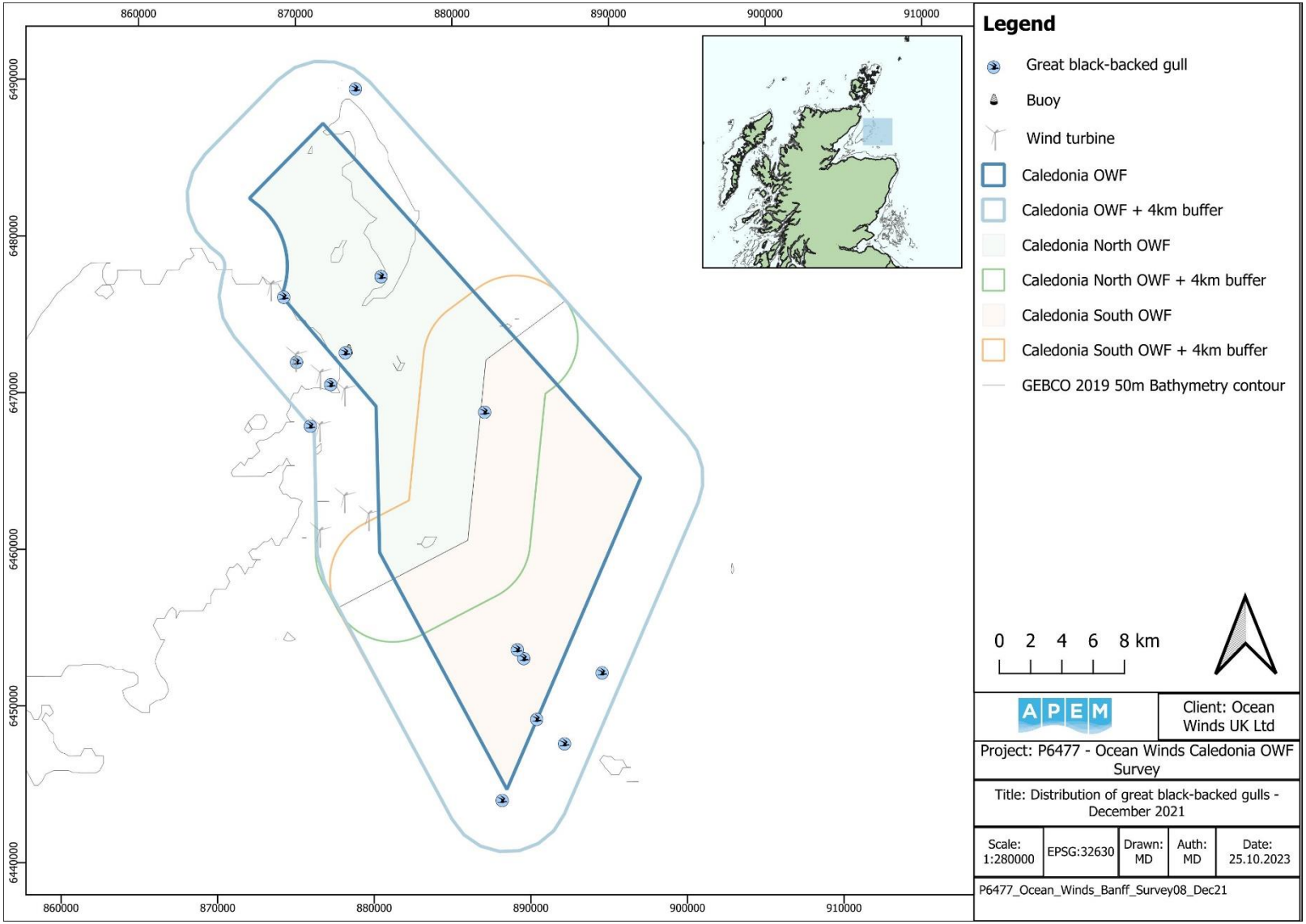



**Figure A4.79 Distribution of great black-backed gulls recorded in the Survey Area in December 2021**

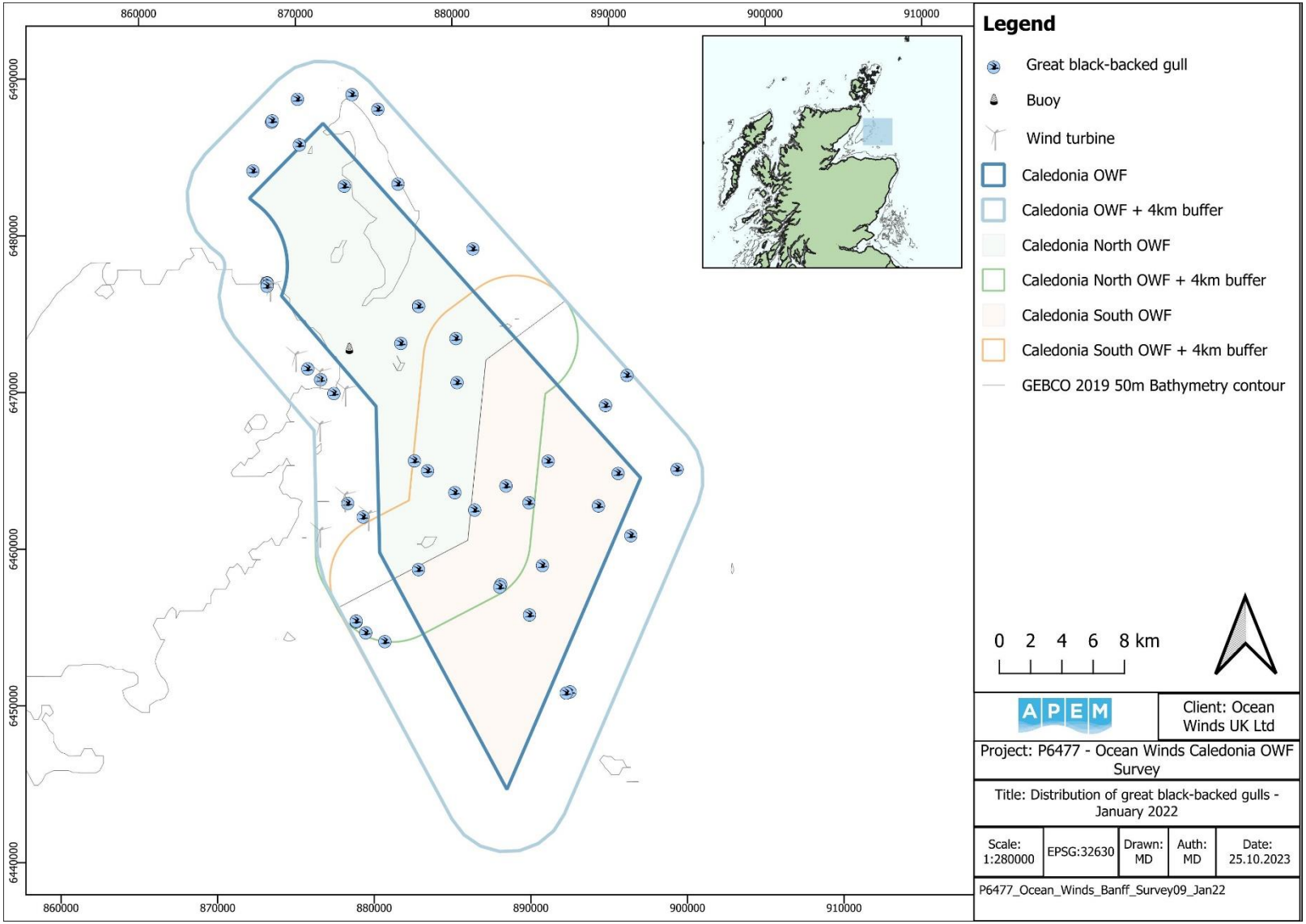



**Figure A4.80 Distribution of great black-backed gulls recorded in the Survey Area in January 2022**

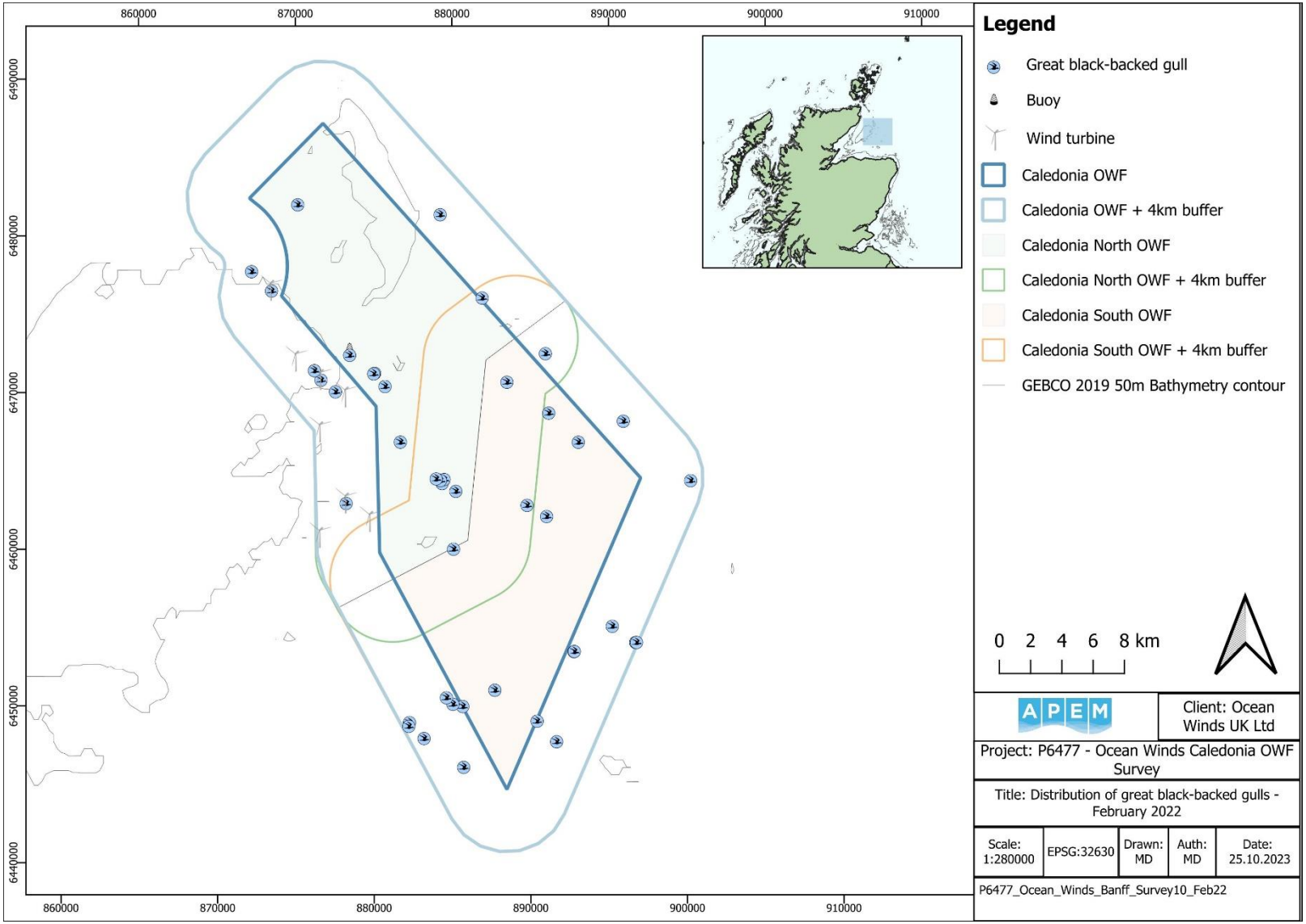



**Figure A4.81 Distribution of great black-backed gulls recorded in the Survey Area in February 2022**

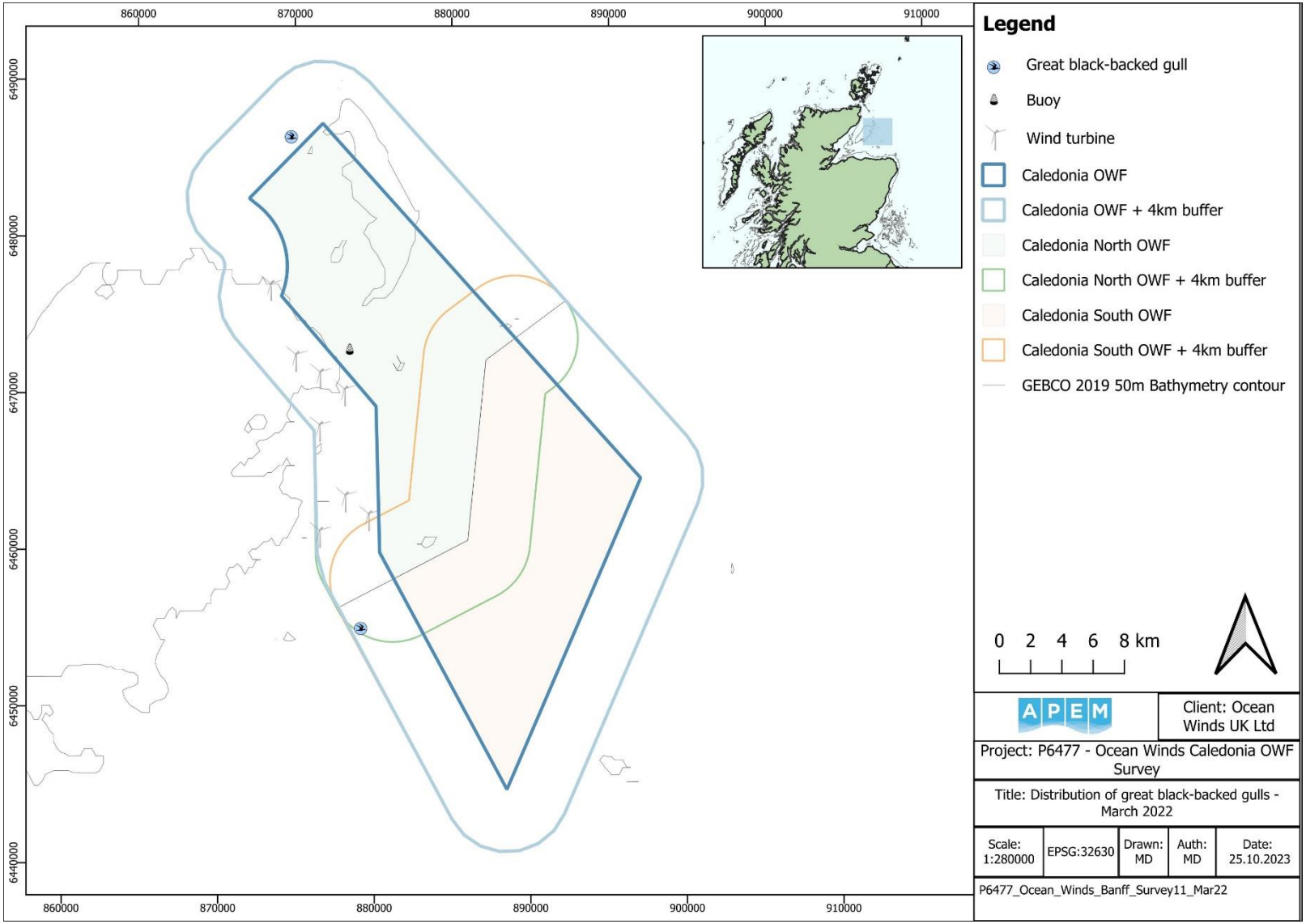



**Figure A4.82 Distribution of great black-backed gulls recorded in the Survey Area in March 2022**

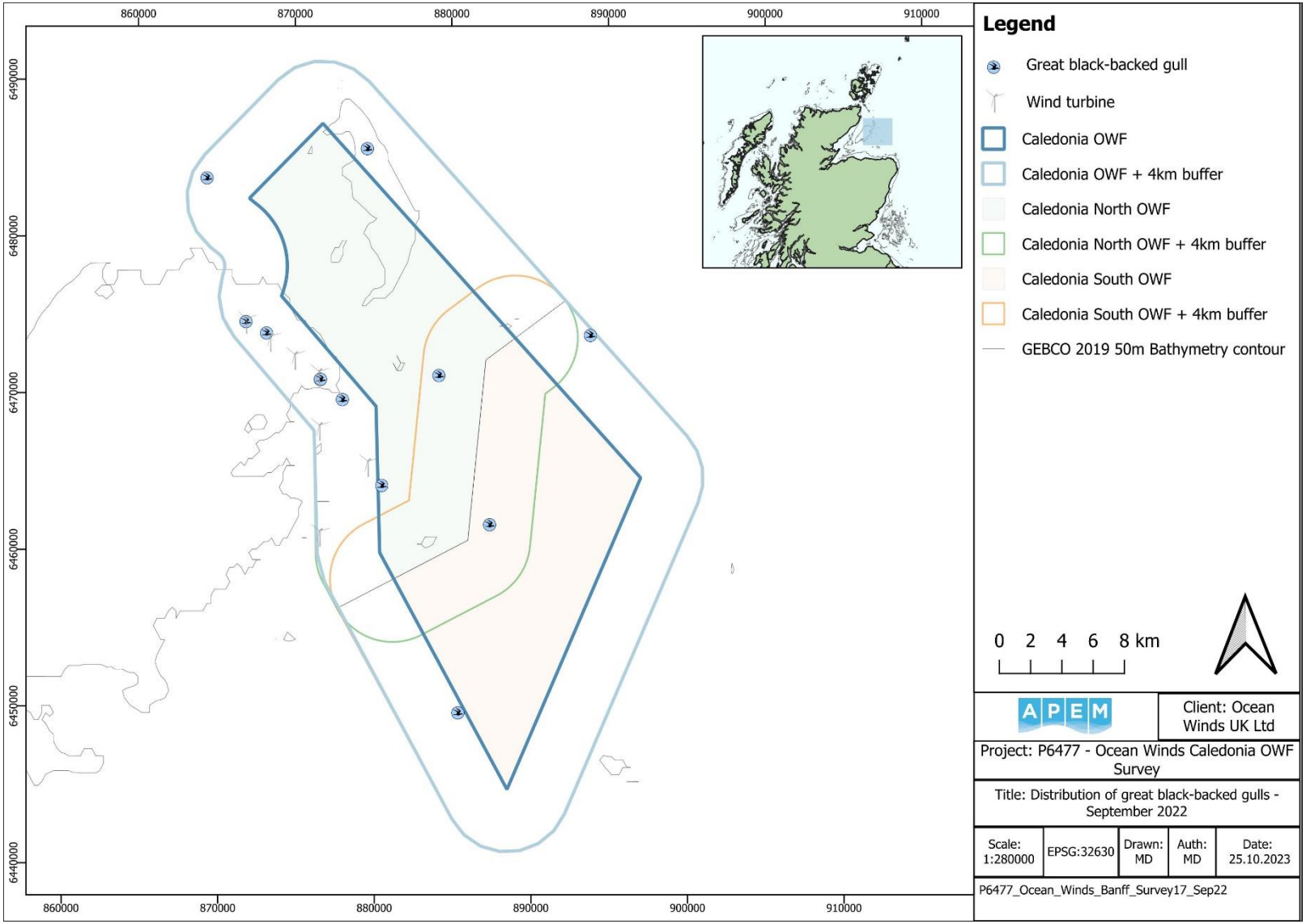



**Figure A4.83 Distribution of great black-backed gulls recorded in the Survey Area in September 2022**

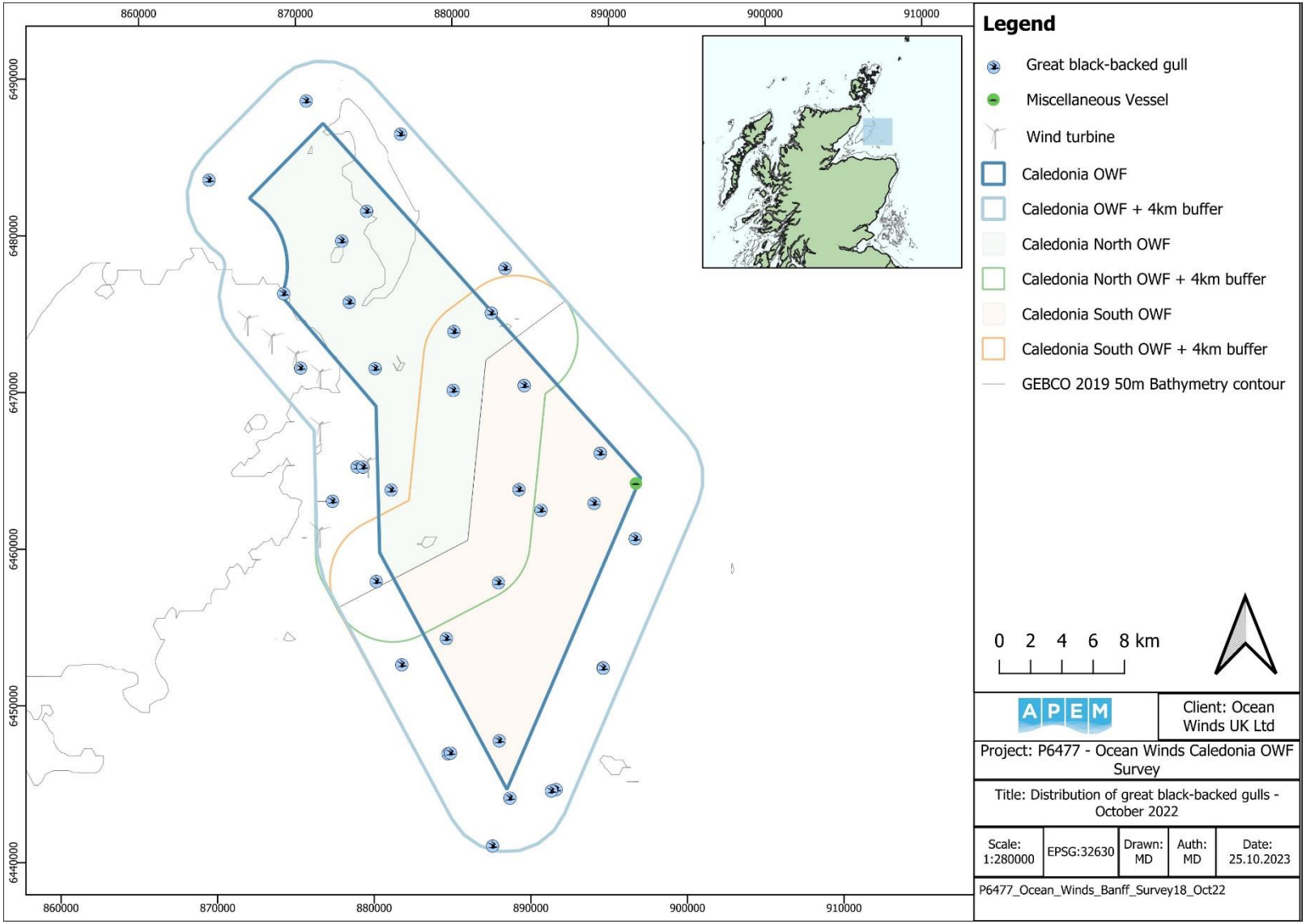



**Figure A4.84 Distribution of great black-backed gulls recorded in the Survey Area in October 2022**

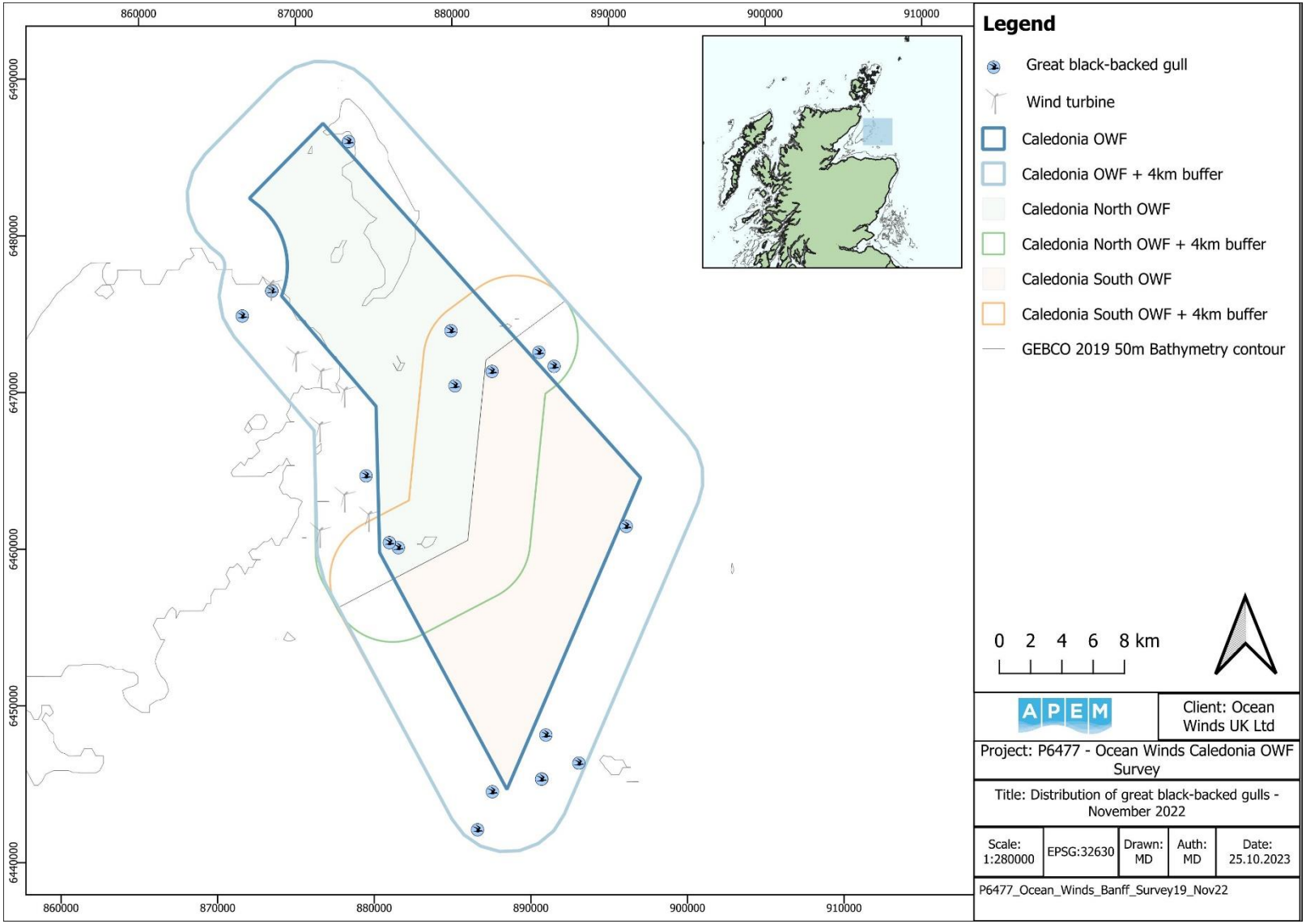



**Figure A4.85 Distribution of great black-backed gulls recorded in the Survey Area in November 2022**

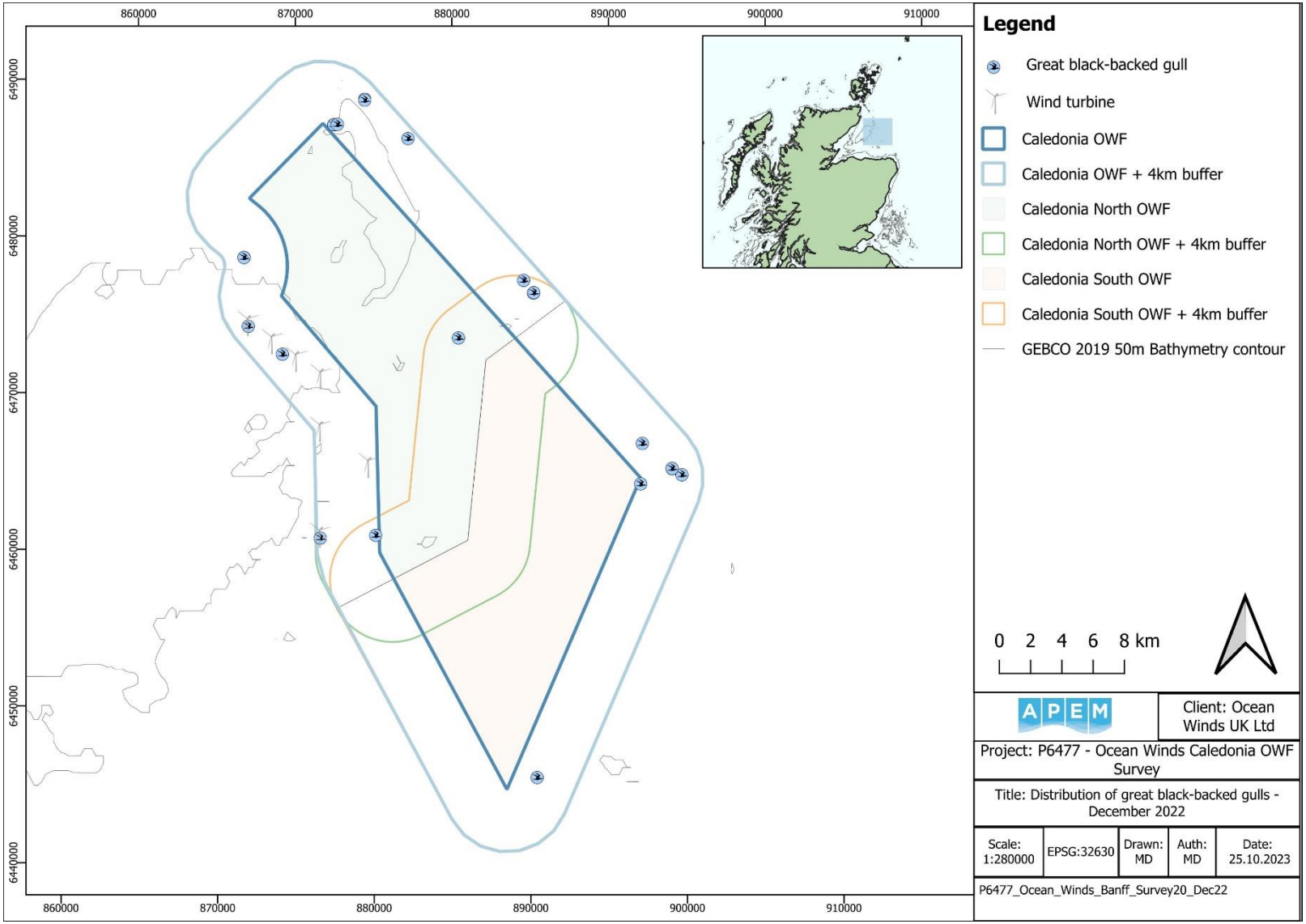



**Figure A4.86 Distribution of great black-backed gulls recorded in the Survey Area in December 2022**

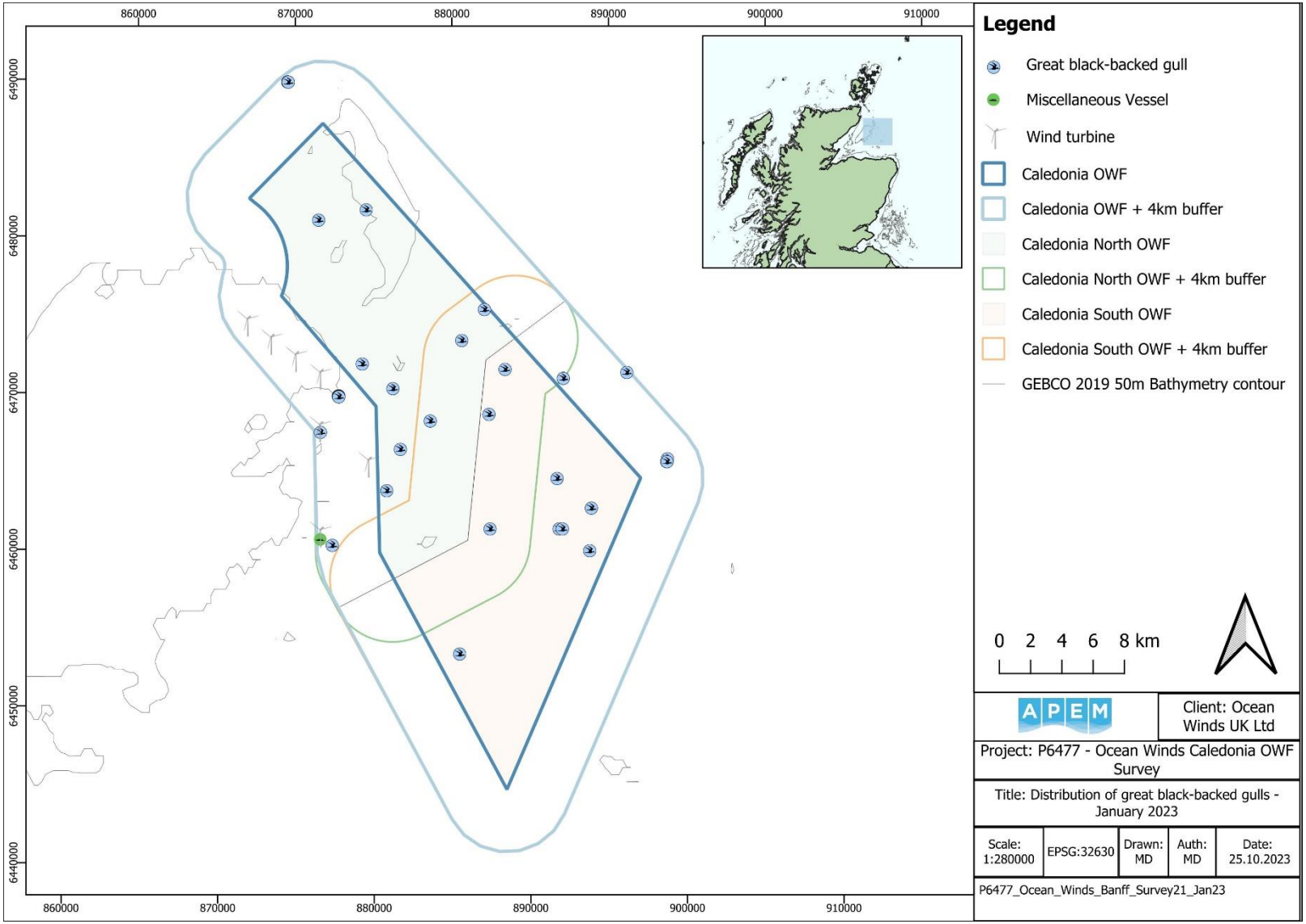



**Figure A4.87 Distribution of great black-backed gulls recorded in the Survey Area in January 2023**

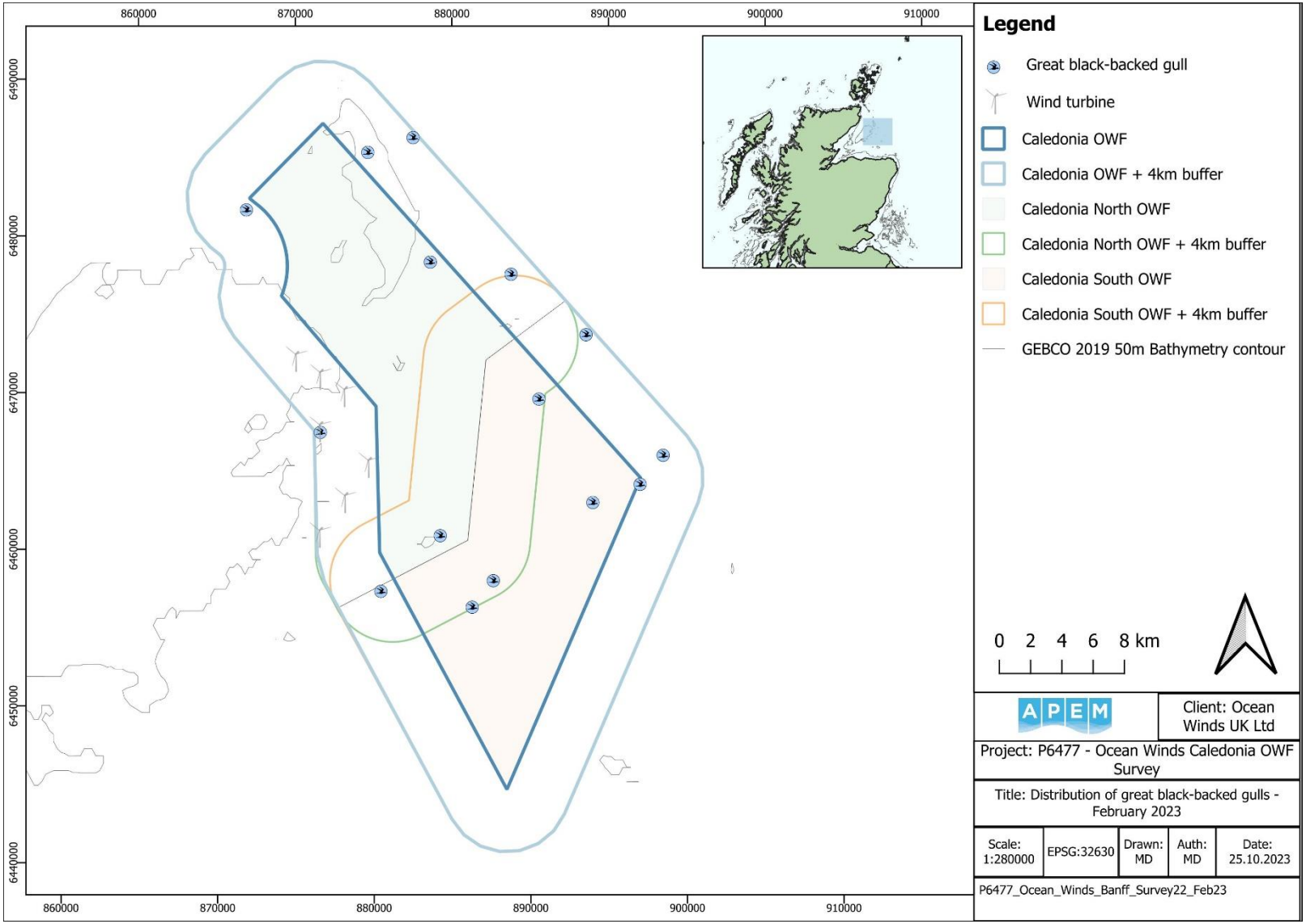



**Figure A4.88 Distribution of great black-backed gulls recorded in the Survey Area in February 2023**

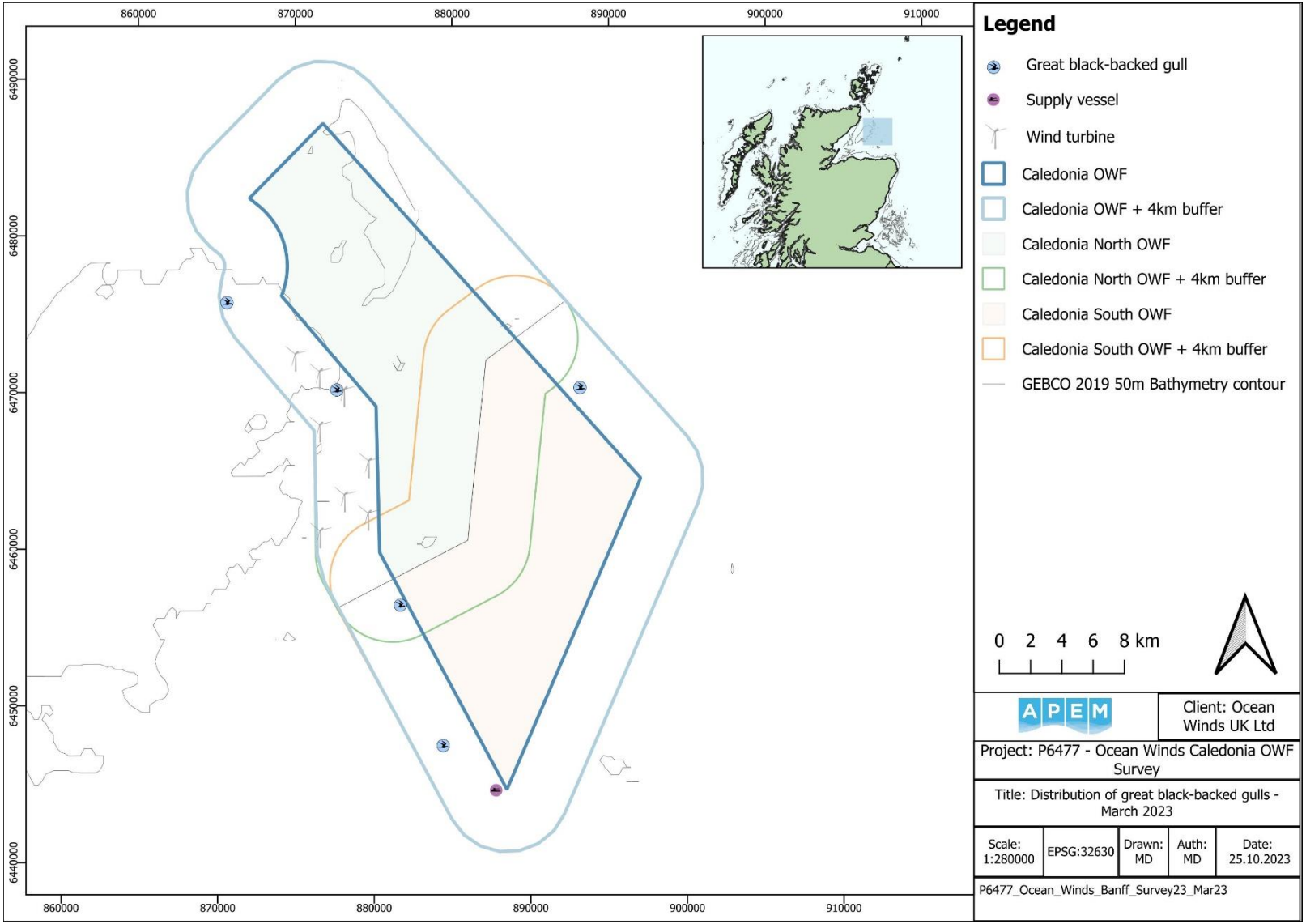



**Figure A4.89 Distribution of great black-backed gulls recorded in the Survey Area in March 2023**

## Herring gull

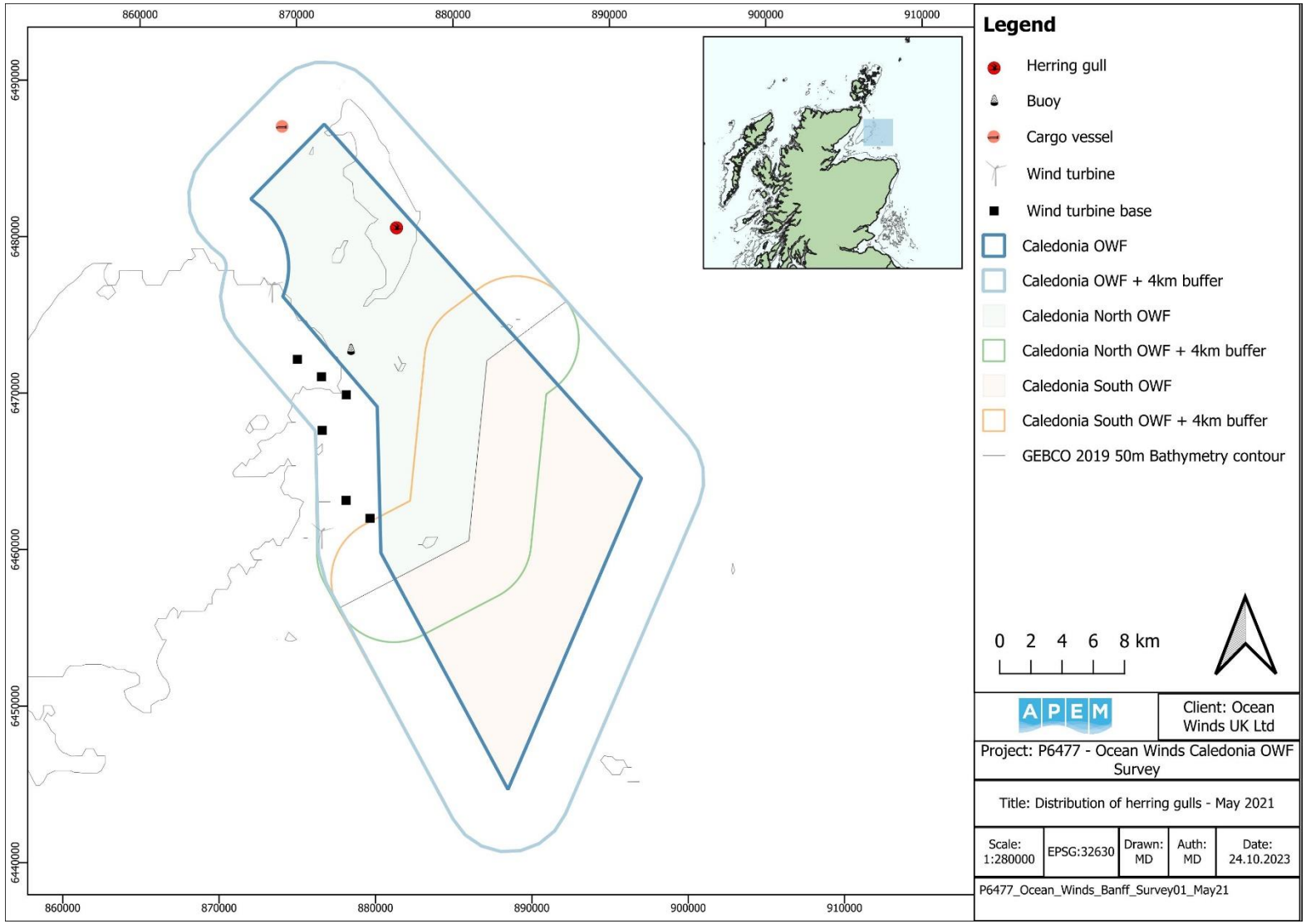



**Figure A4.90 Distribution of herring gulls recorded in the Survey Area in May 2021**

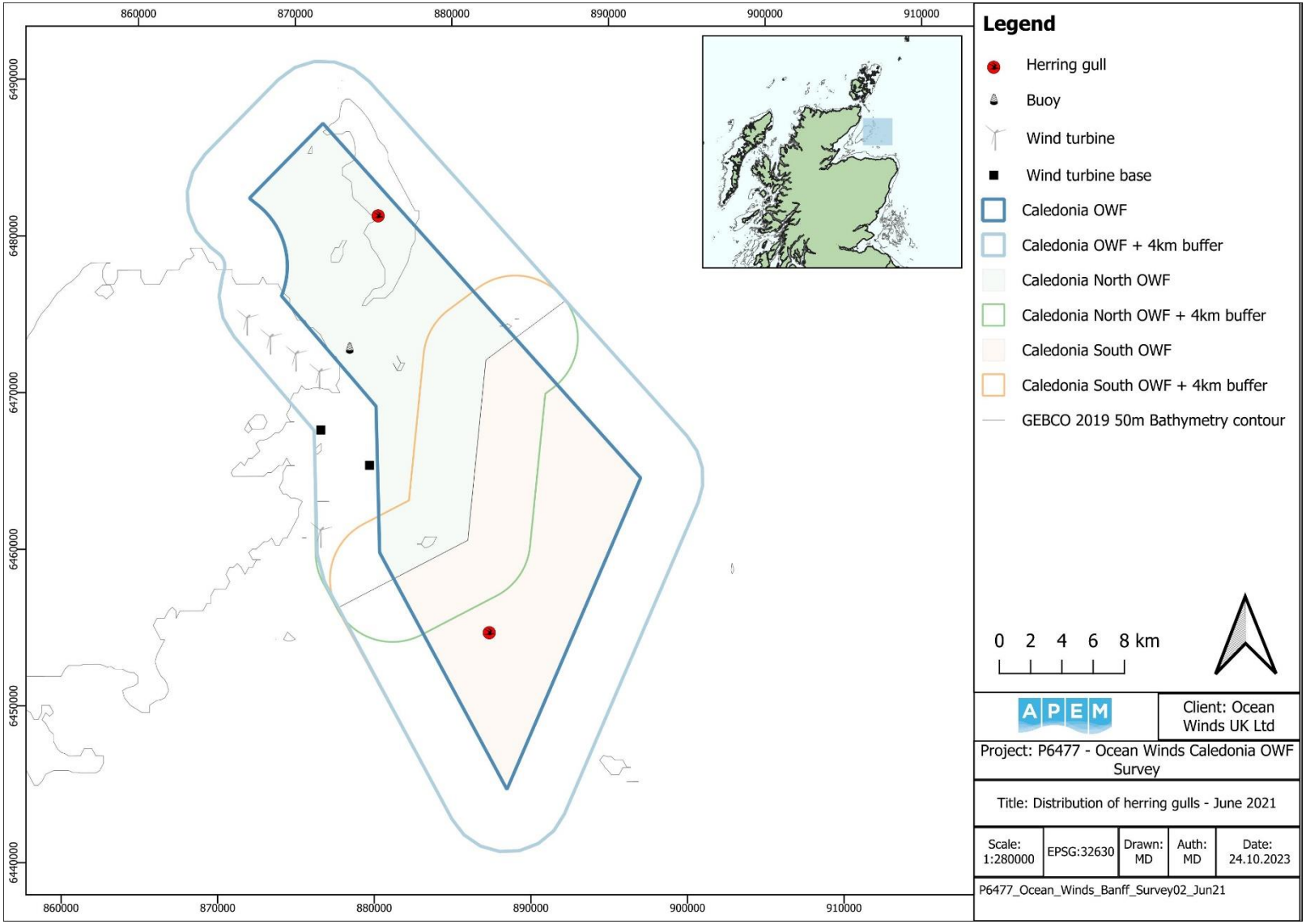



**Figure A4.91 Distribution of herring gulls recorded in the Survey Area in June 2021**

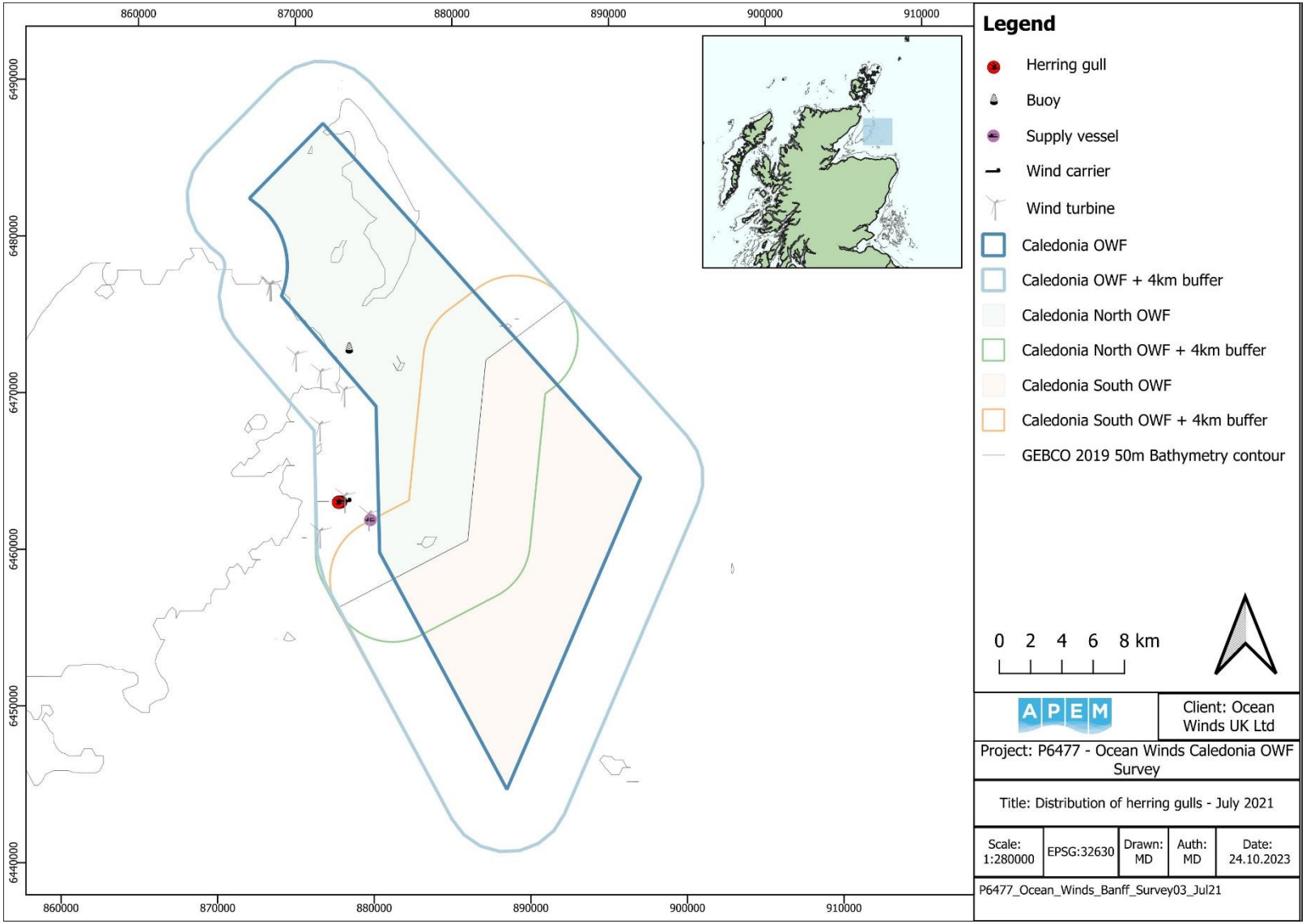



**Figure A4.92 Distribution of herring gulls recorded in the Survey Area in July 2021**

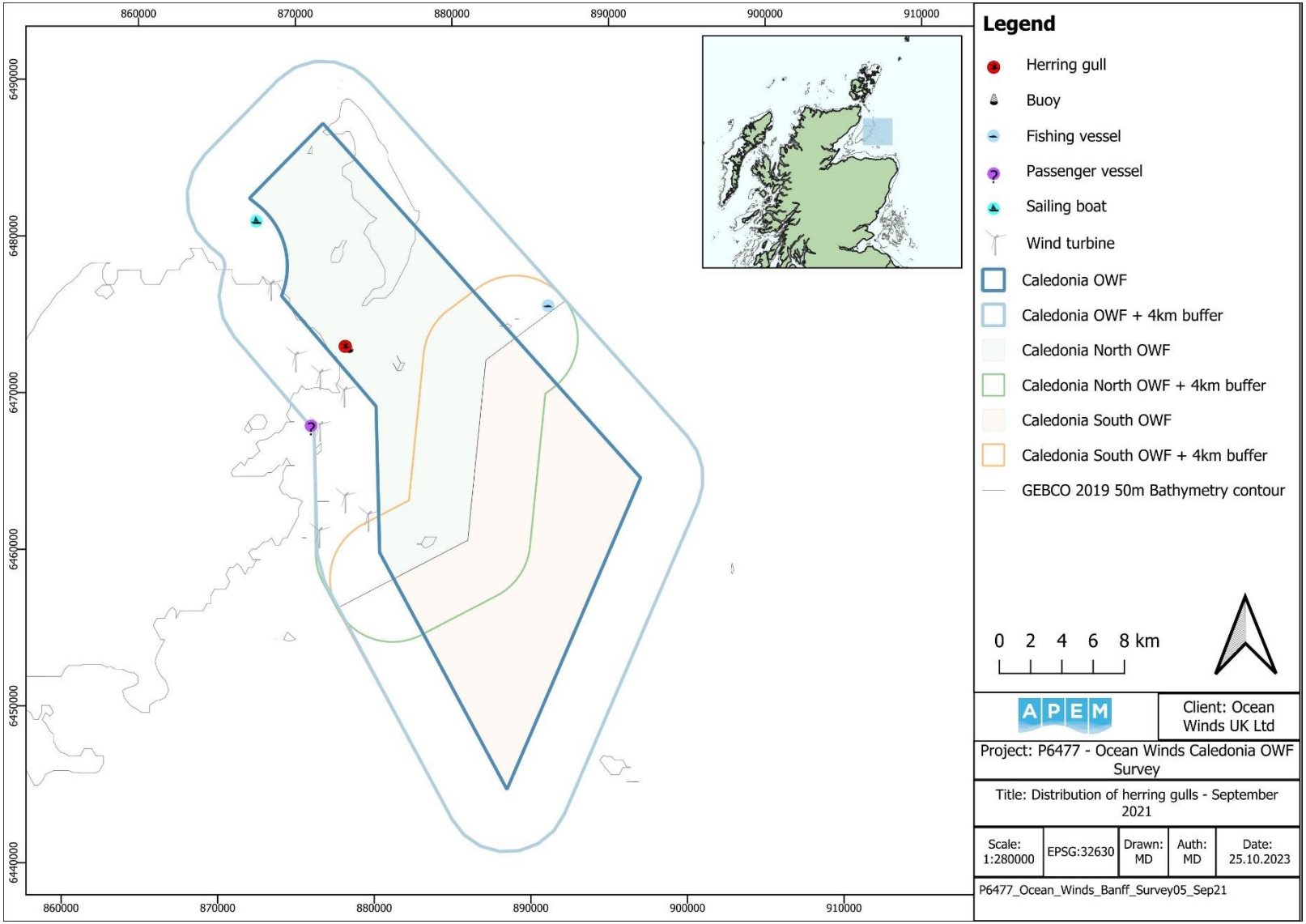



**Figure A4.93 Distribution of herring gulls recorded in the Survey Area in September 2021**

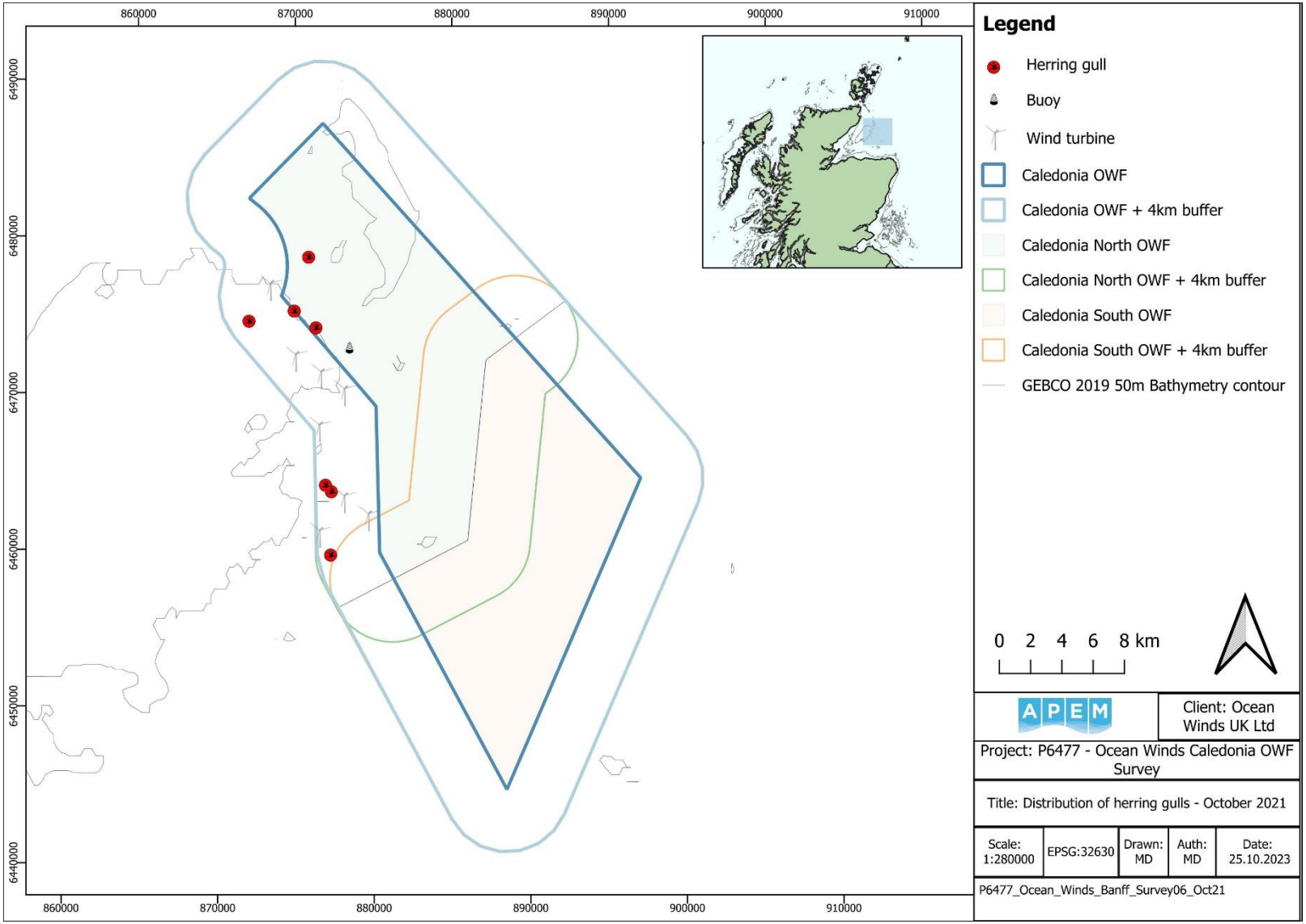



**Figure A4.94 Distribution of herring gulls recorded in the Survey Area in October 2021**

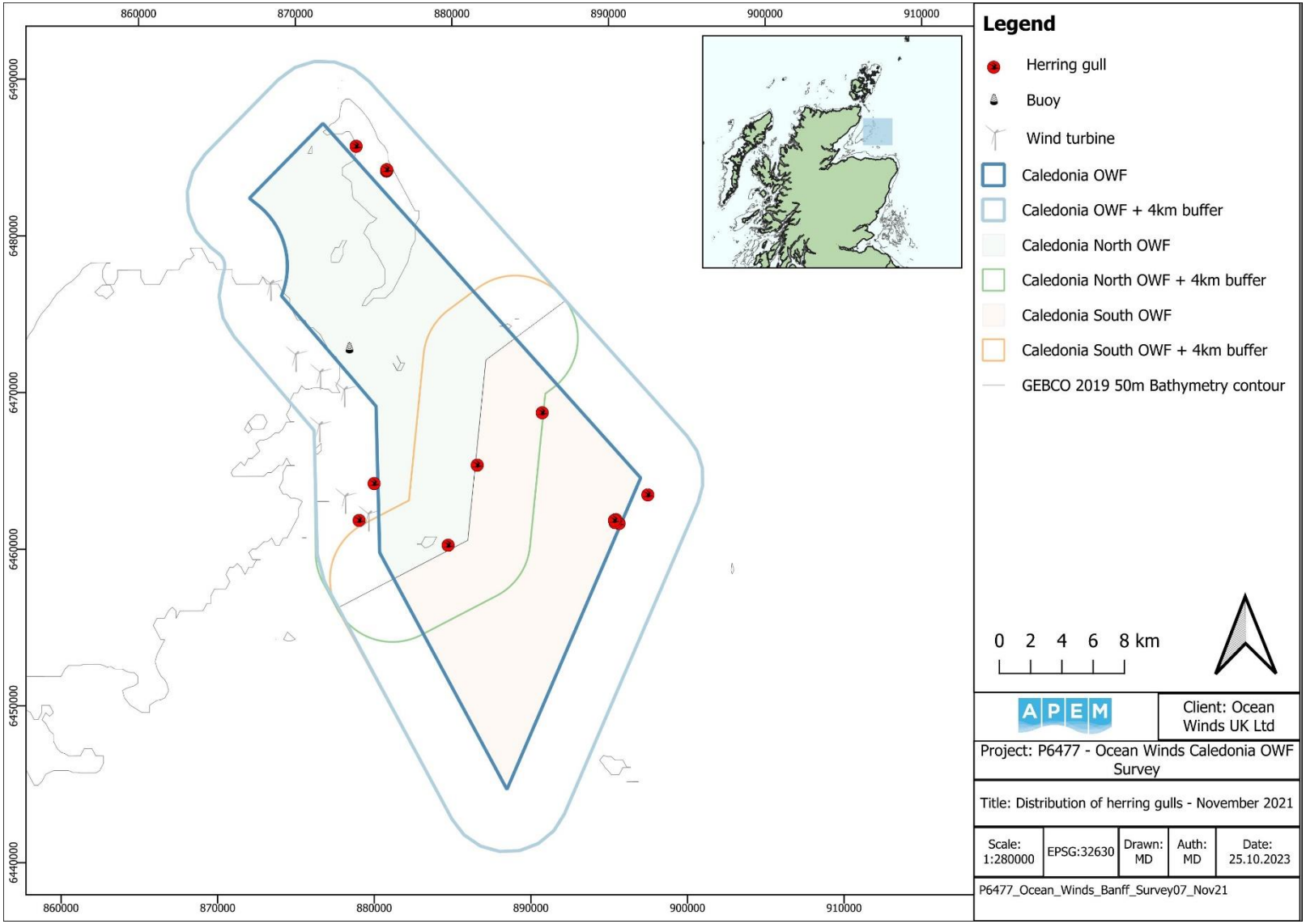



**Figure A4.95 Distribution of herring gulls recorded in the Survey Area in November 2021**

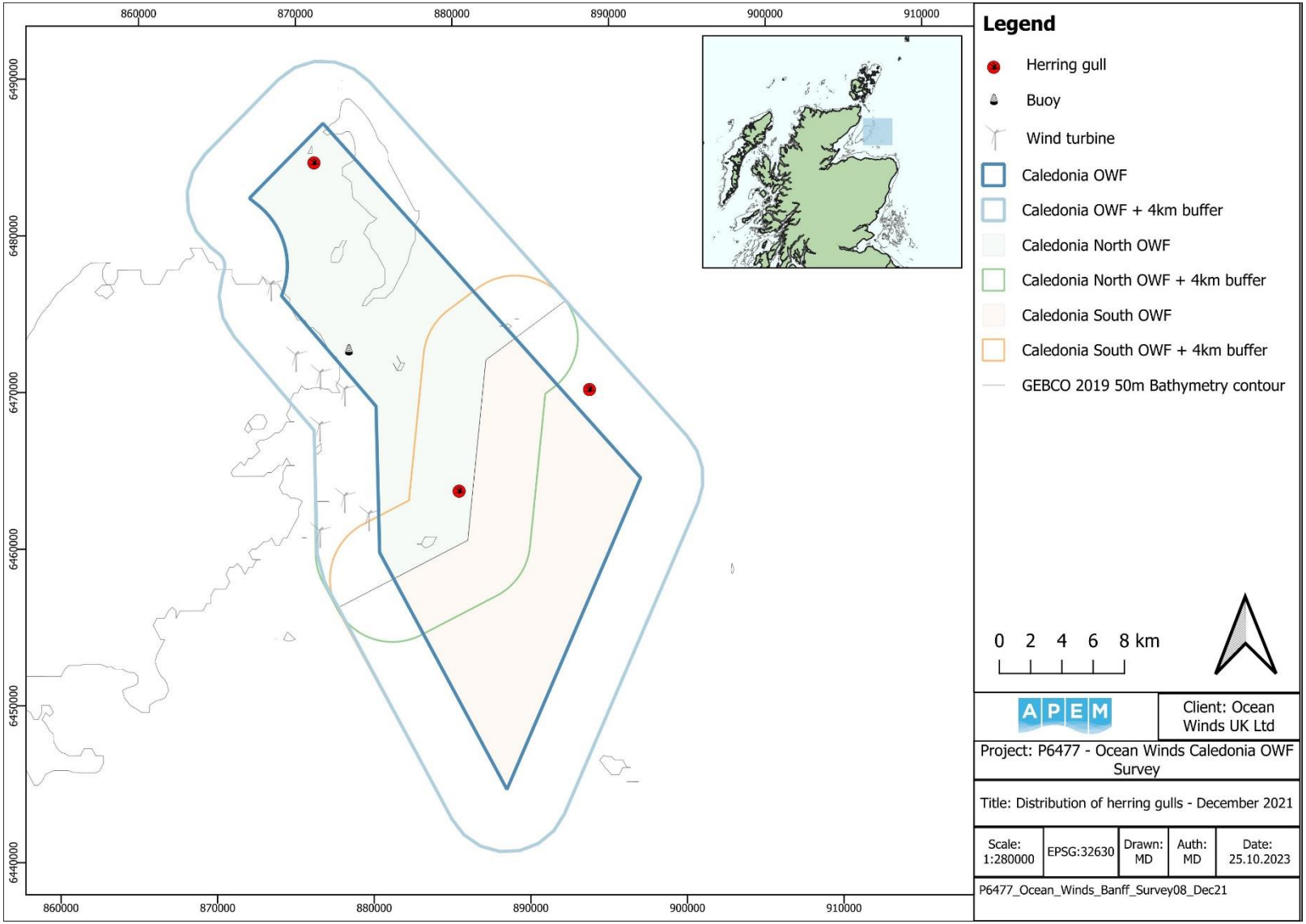



**Figure A4.96 Distribution of herring gulls recorded in the Survey Area in December 2021**

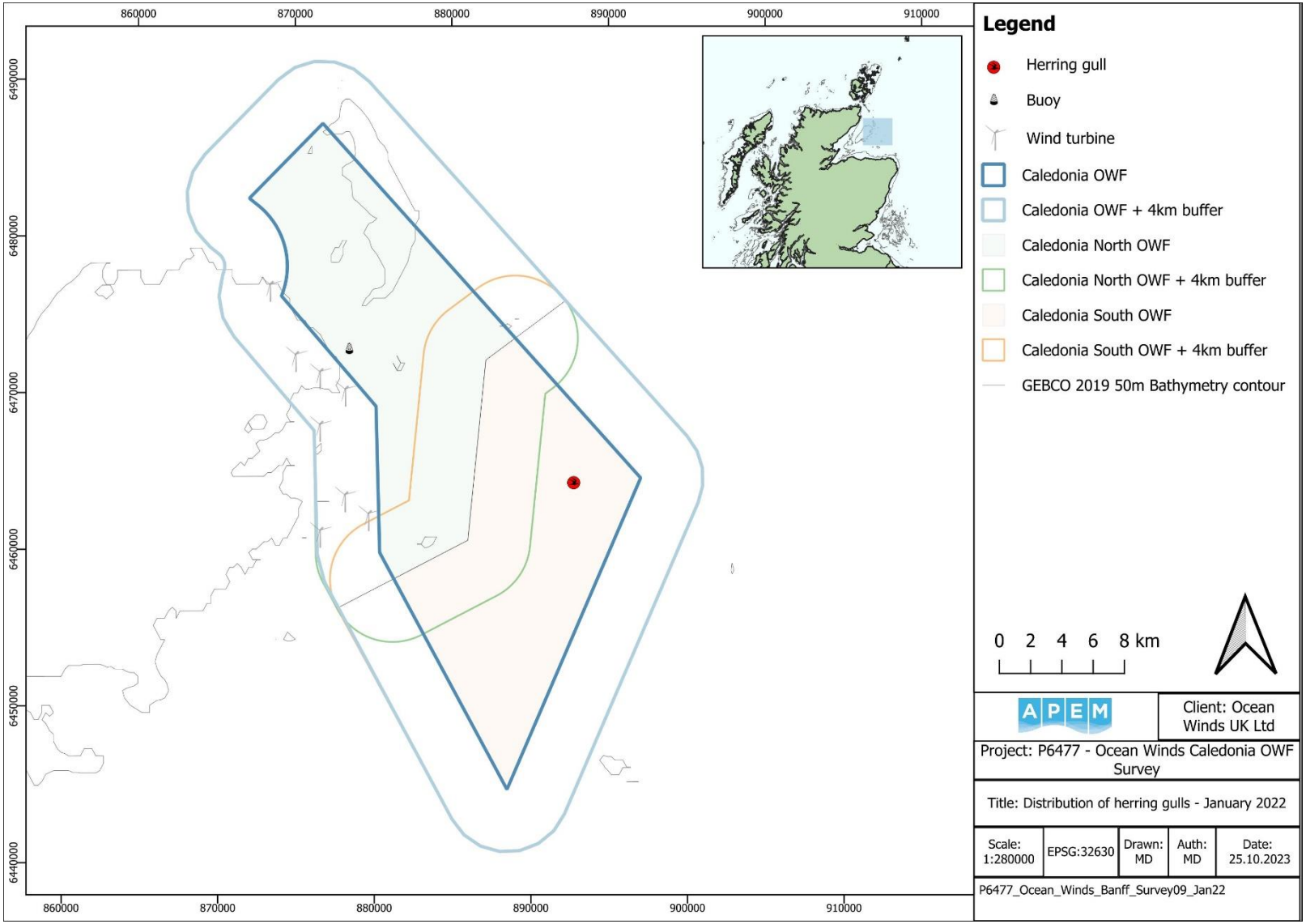



**Figure A4.97 Distribution of herring gulls recorded in the Survey Area in January 2022**

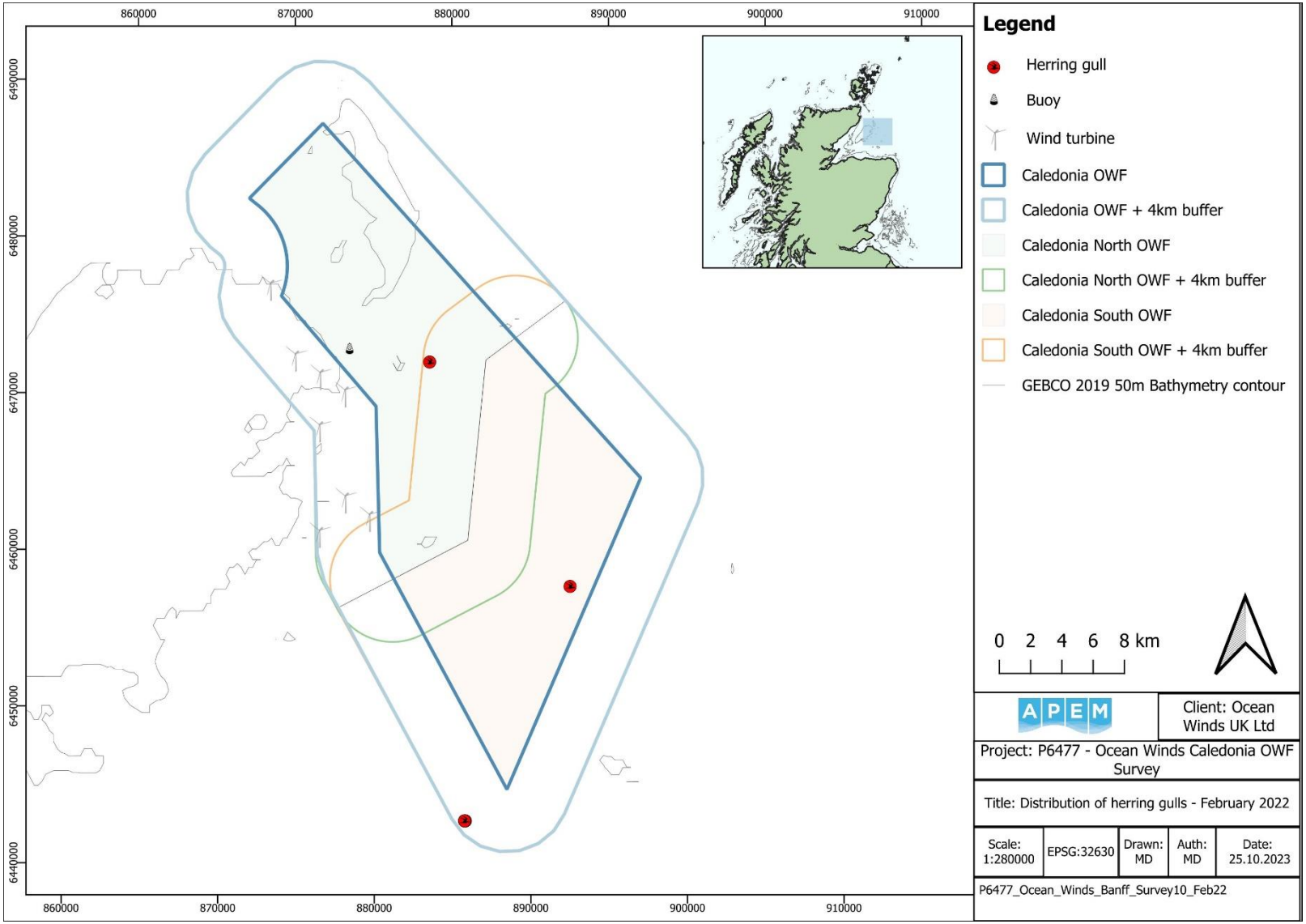



**Figure A4.98 Distribution of herring gulls recorded in the Survey Area in February 2022**

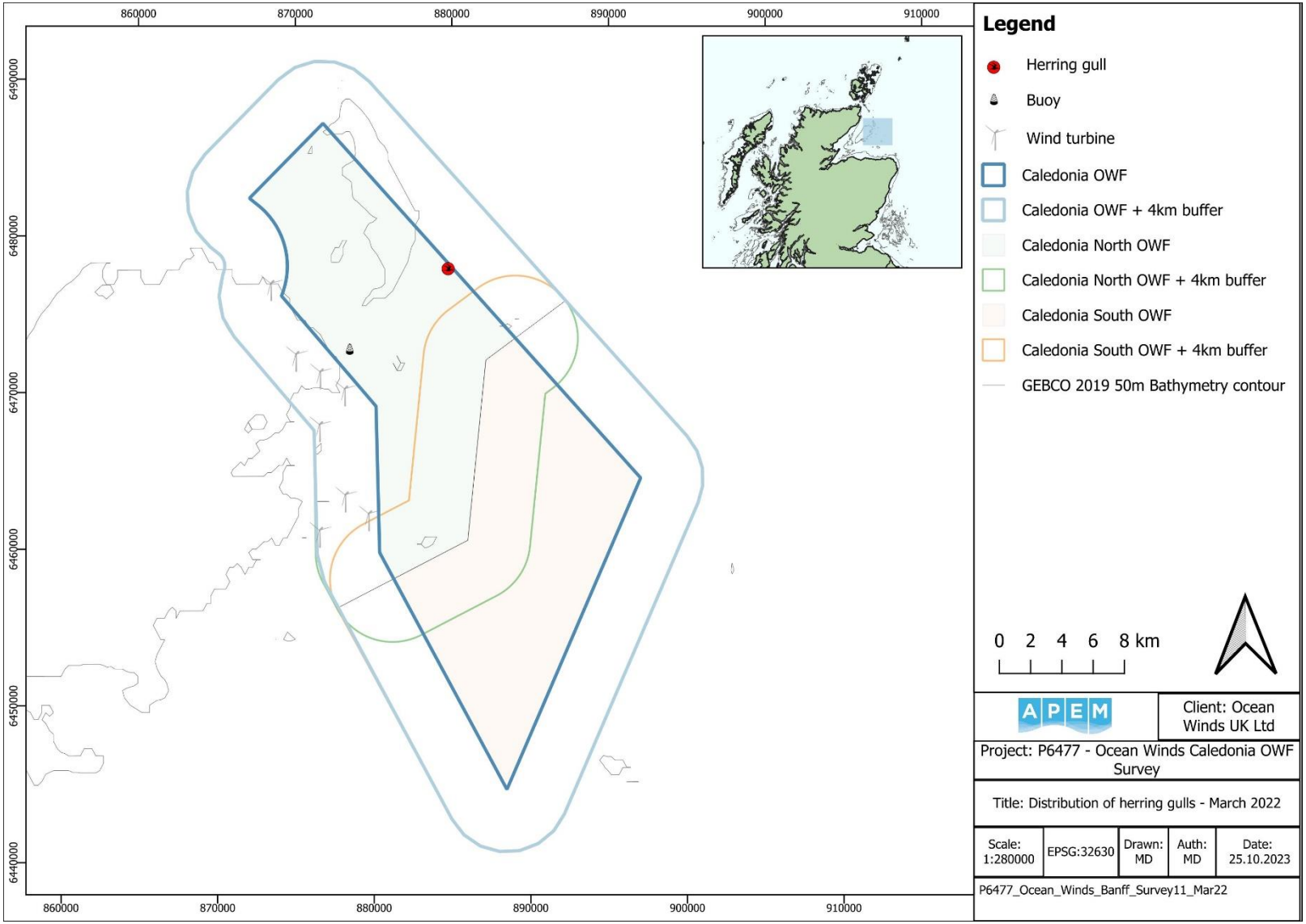



**Figure A4.99 Distribution of herring gulls recorded in the Survey Area in March 2022**

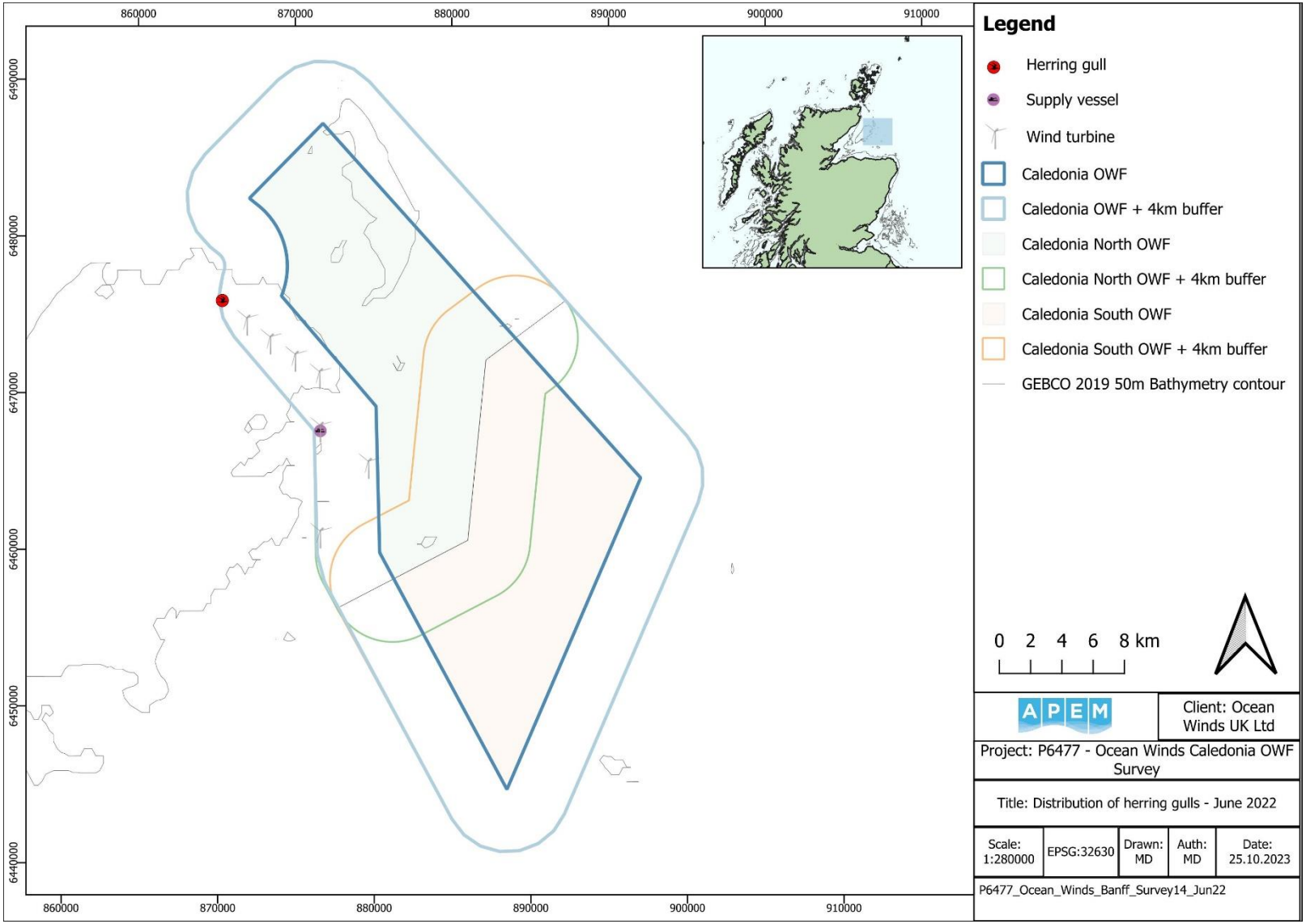



**Figure A4.100 Distribution of herring gulls recorded in the Survey Area in June 2022**

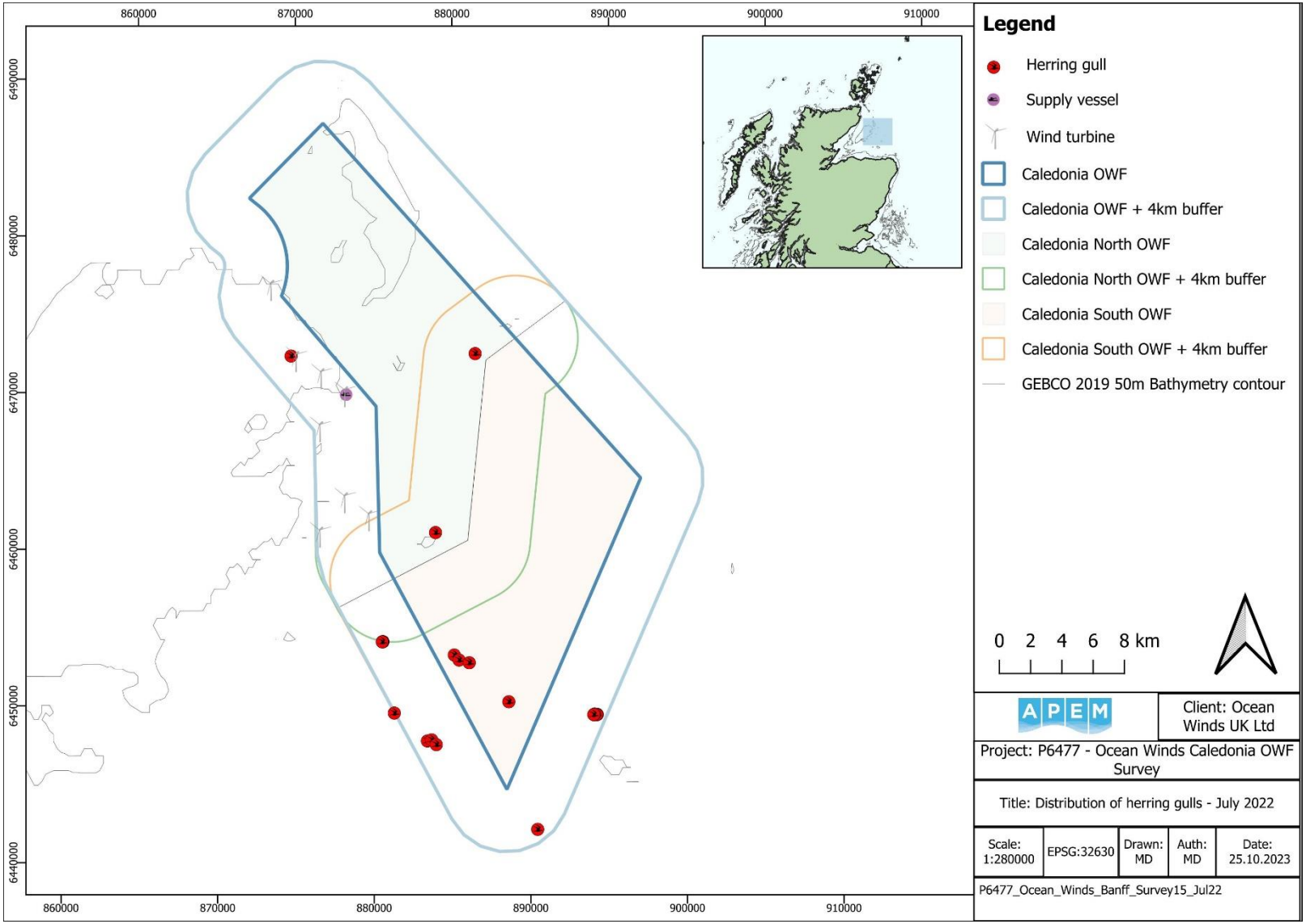



**Figure A4.101 Distribution of herring gulls recorded in the Survey Area in July 2022**

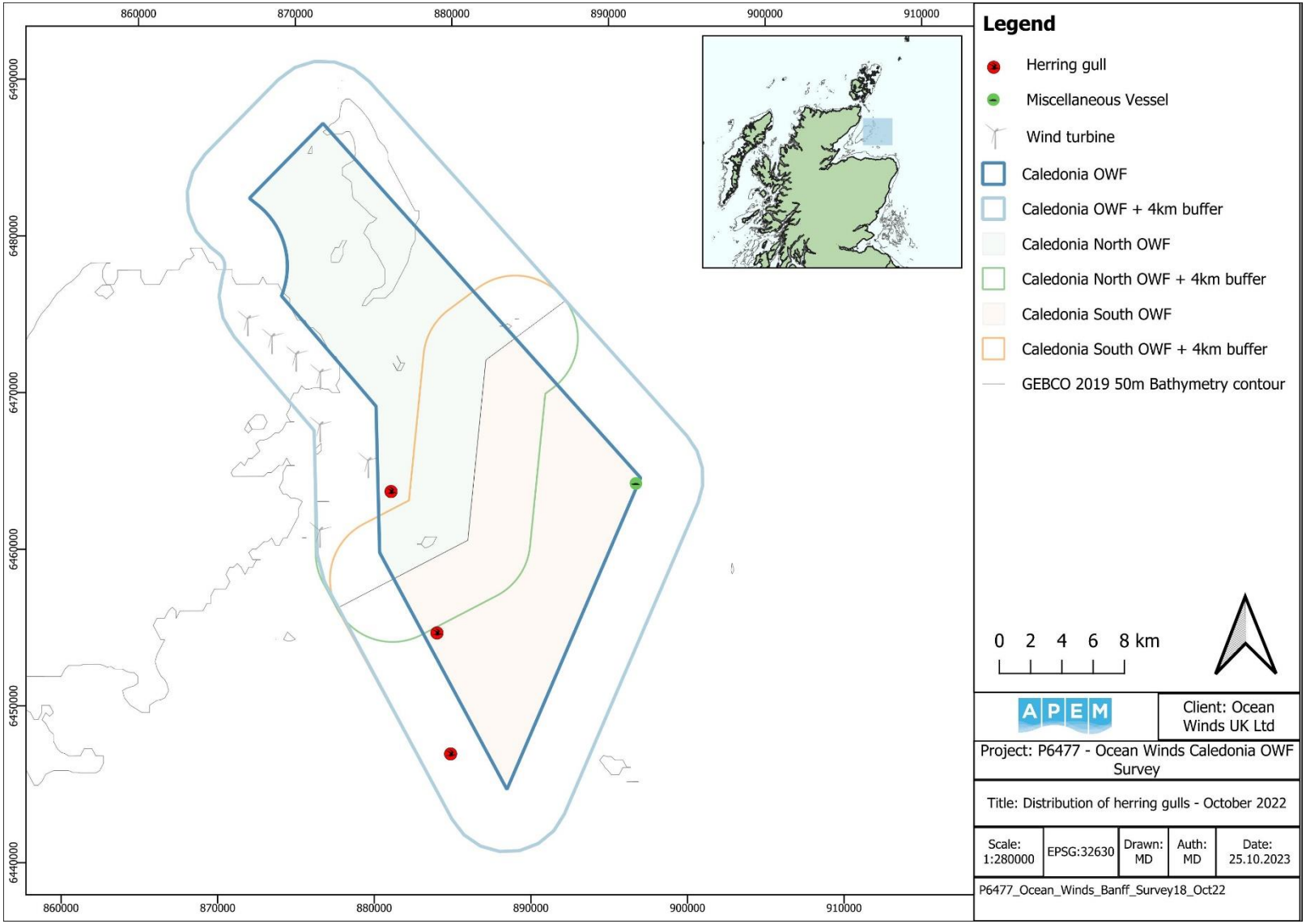



**Figure A4.102 Distribution of herring gulls recorded in the Survey Area in October 2022**

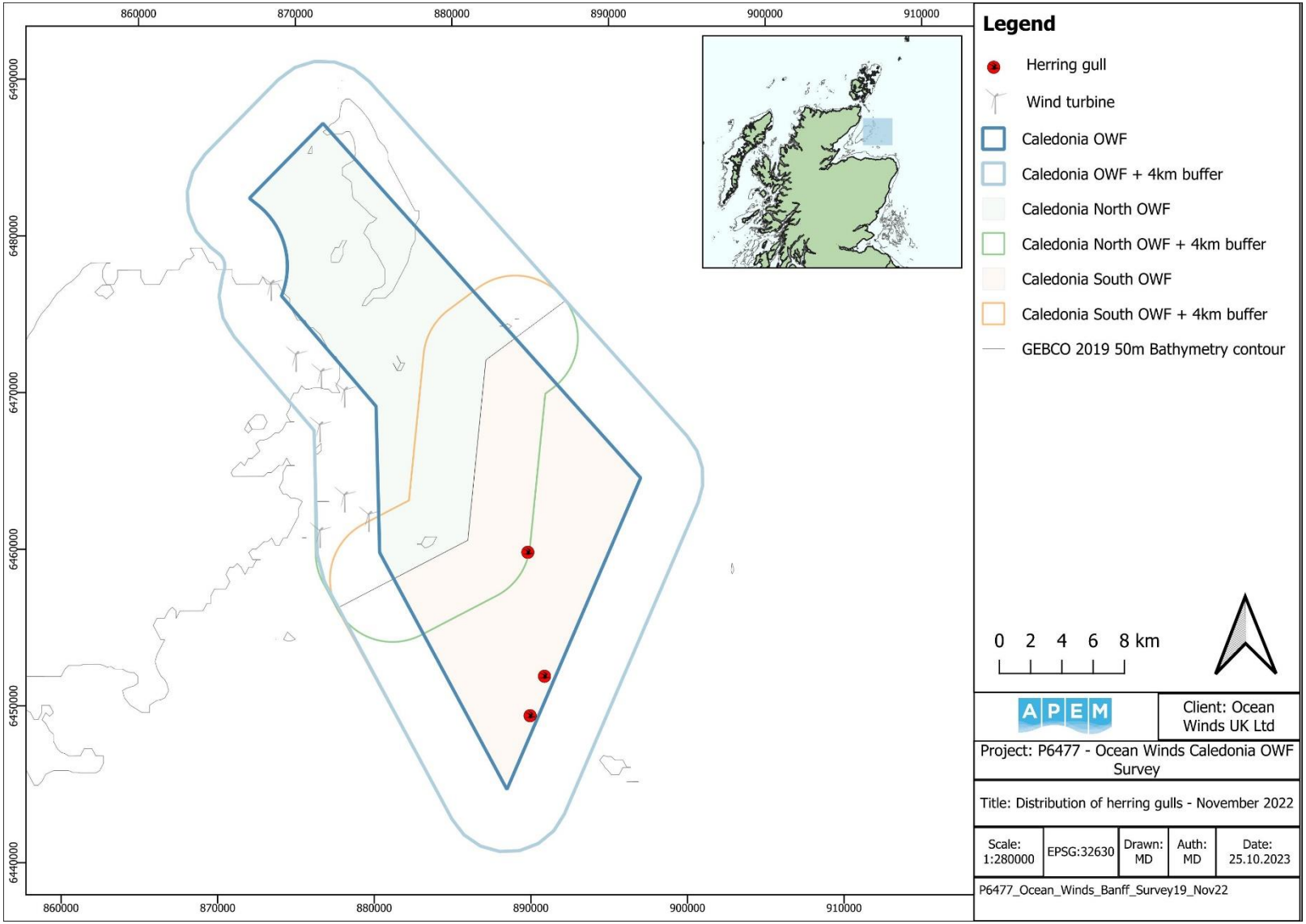



**Figure A4.103 Distribution of herring gulls recorded in the Survey Area in November 2022**

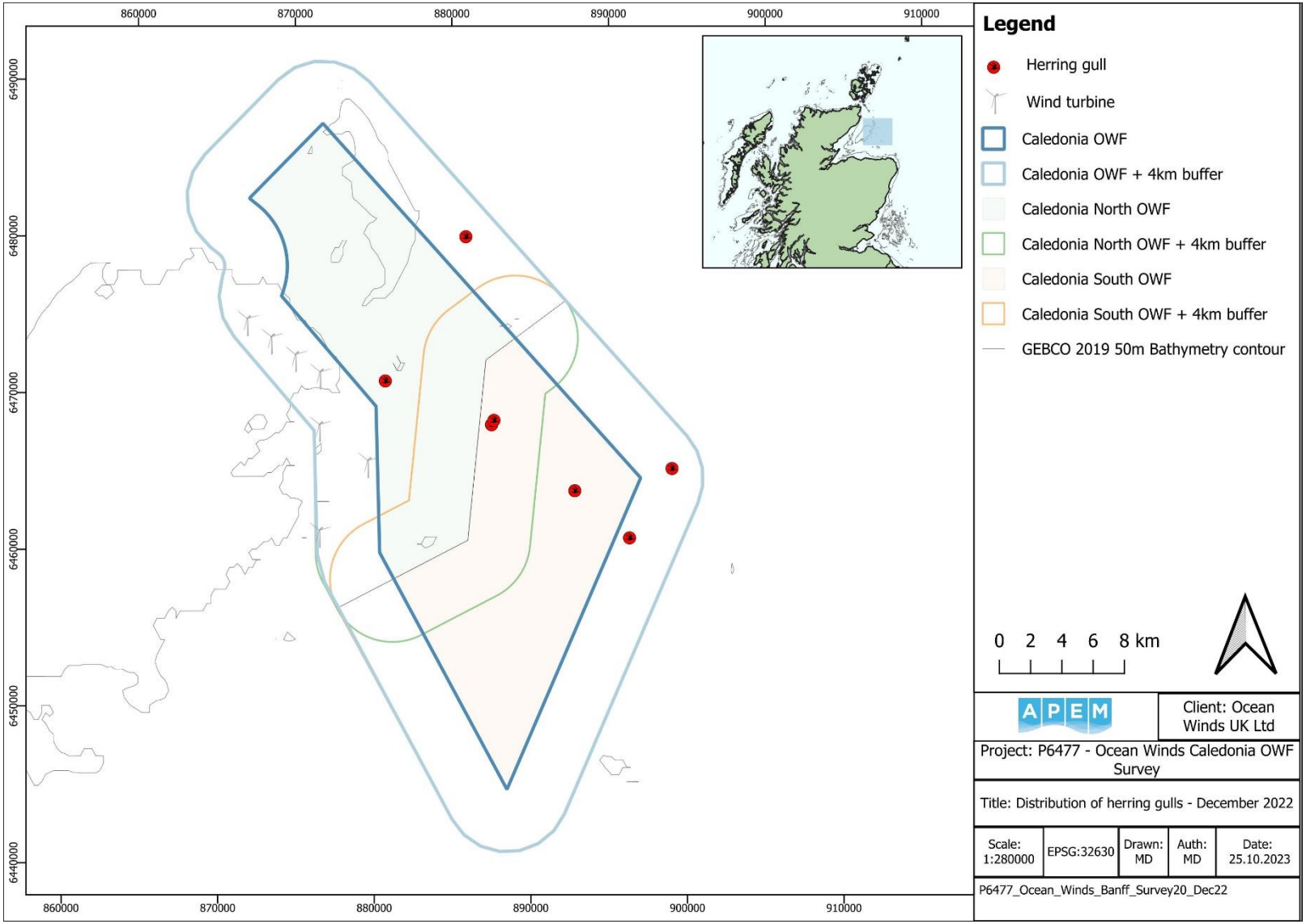



**Figure A4.104 Distribution of herring gulls recorded in the Survey Area in December 2022**

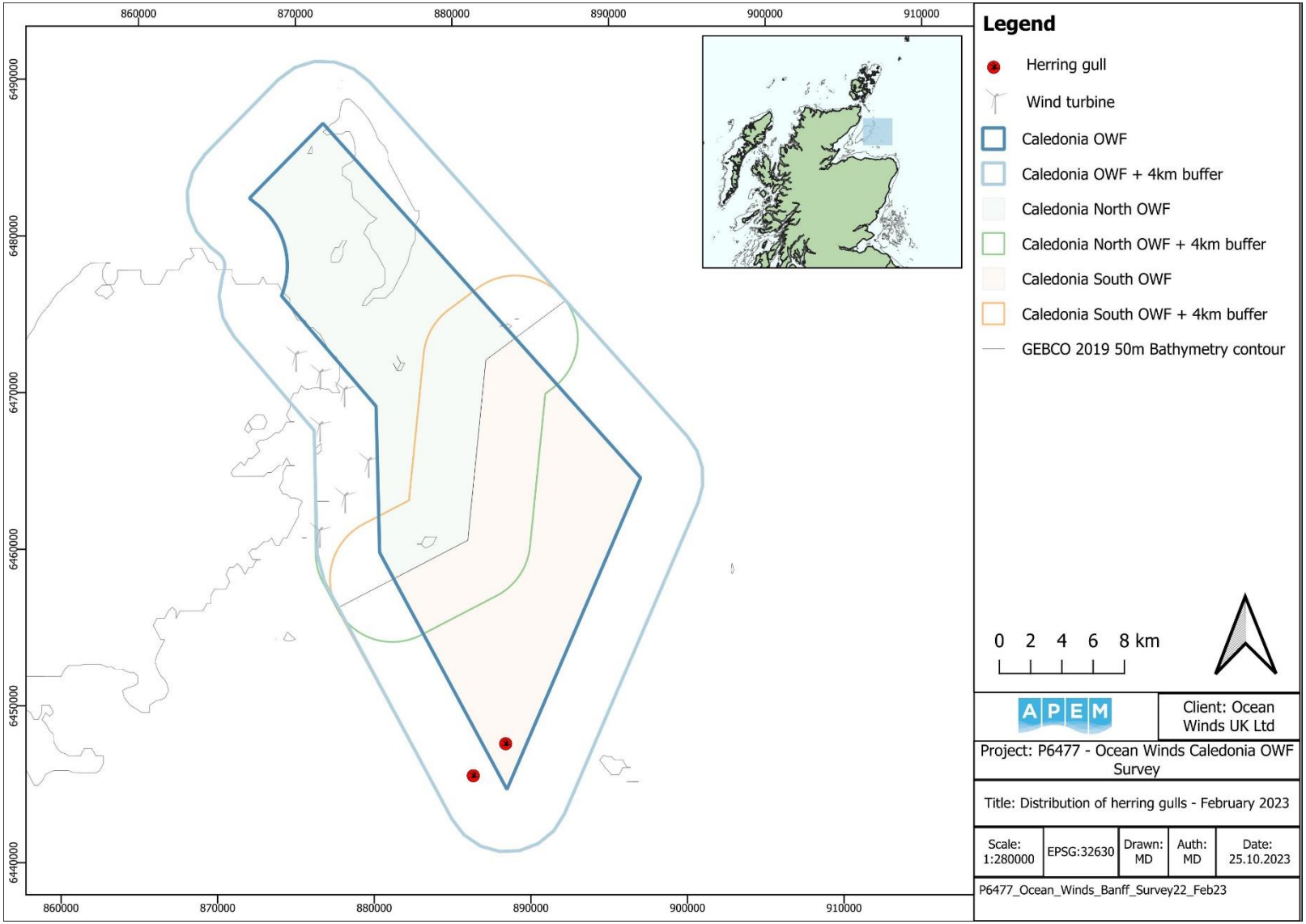



**Figure A4.105 Distribution of herring gulls recorded in the Survey Area in February 2023**

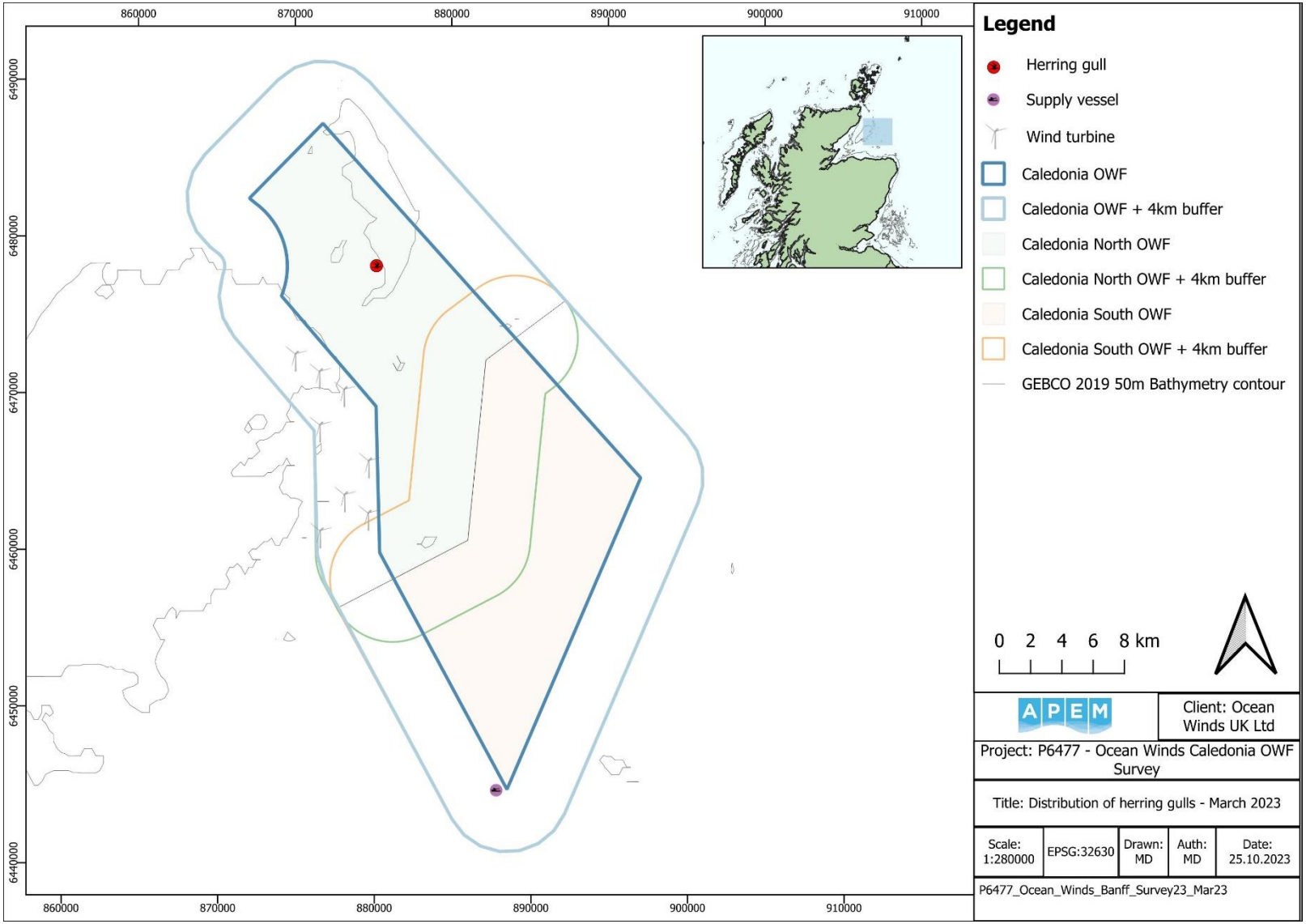



**Figure A4.106 Distribution of herring gulls recorded in the Survey Area in March 2023**

## Lesser black-backed gull

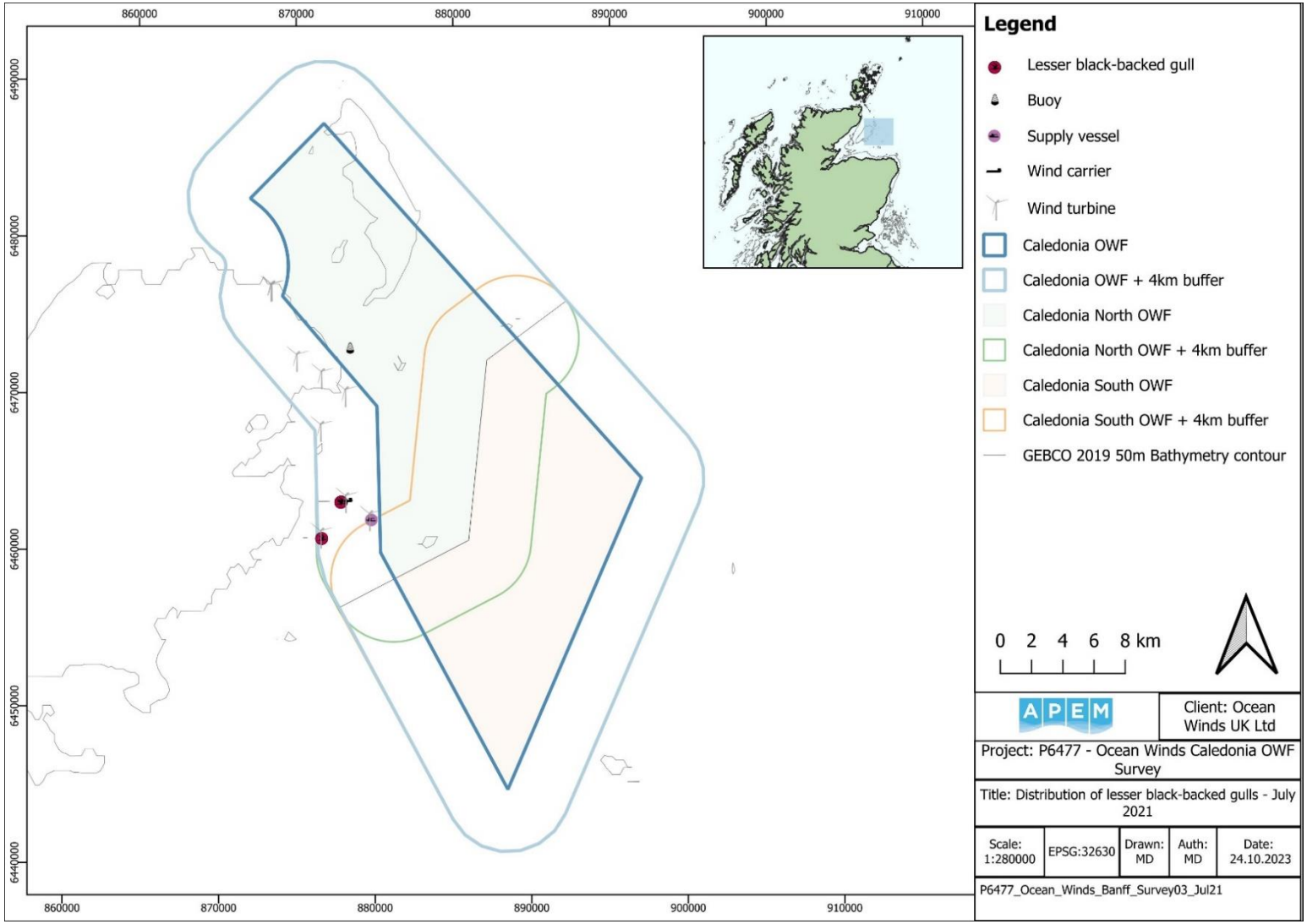



**Figure A4.107 Distribution of lesser black-backed gulls recorded in the Survey Area in July 2021**

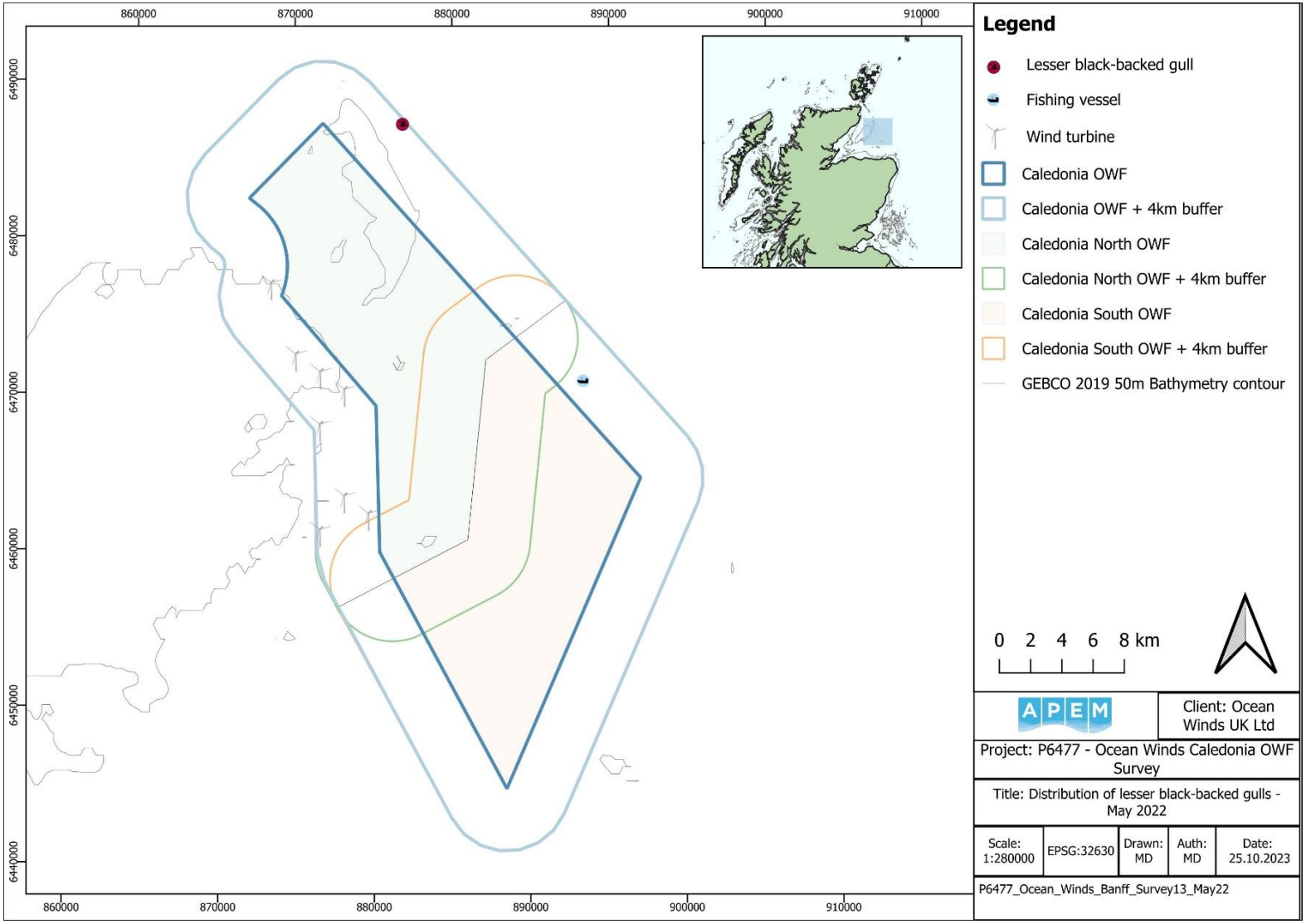



**Figure A4.108 Distribution of lesser black-backed gulls recorded in the Survey Area in May 2022**

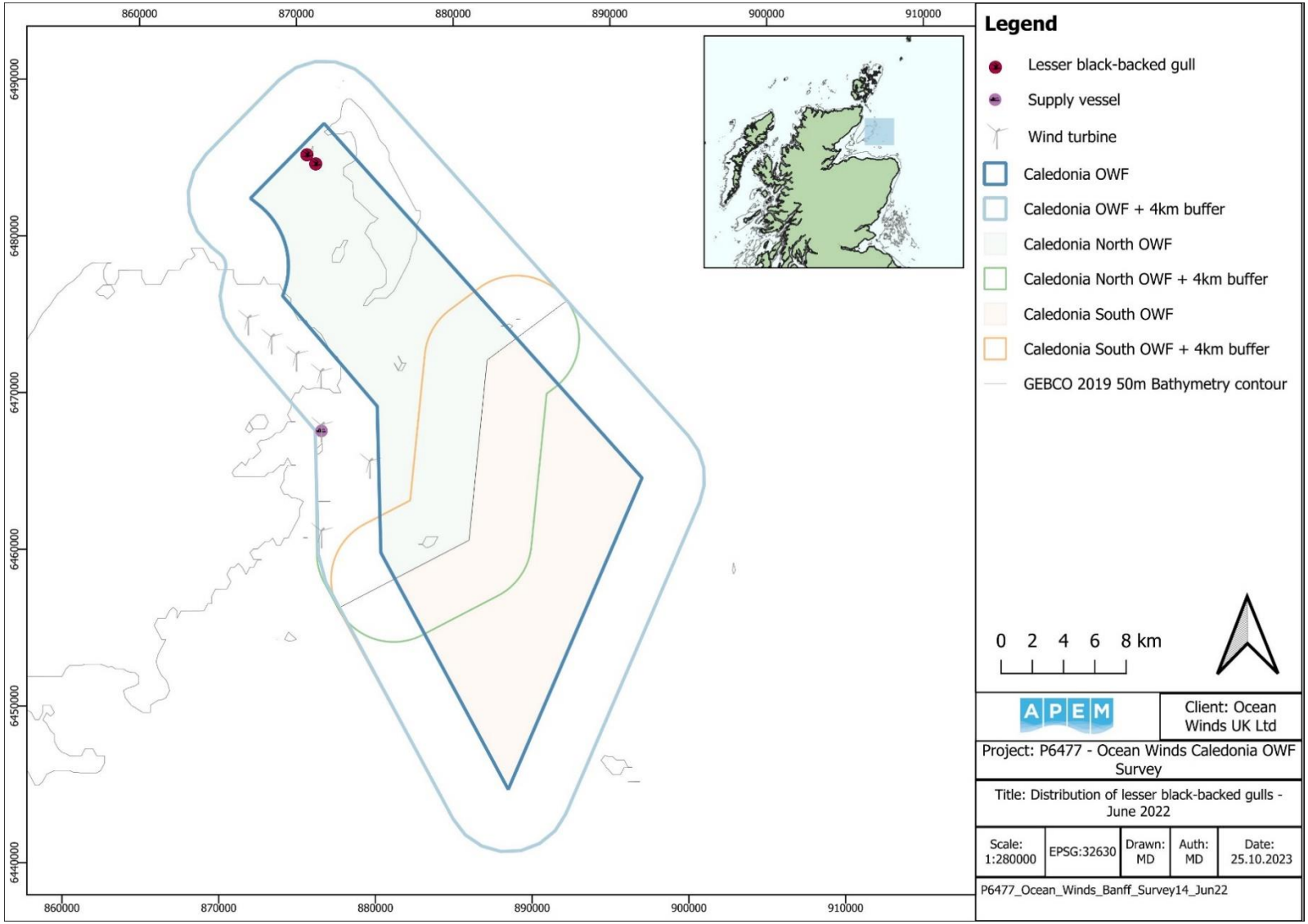



**Figure A4.109 Distribution of lesser black-backed gulls recorded in the Survey Area in June 2022**

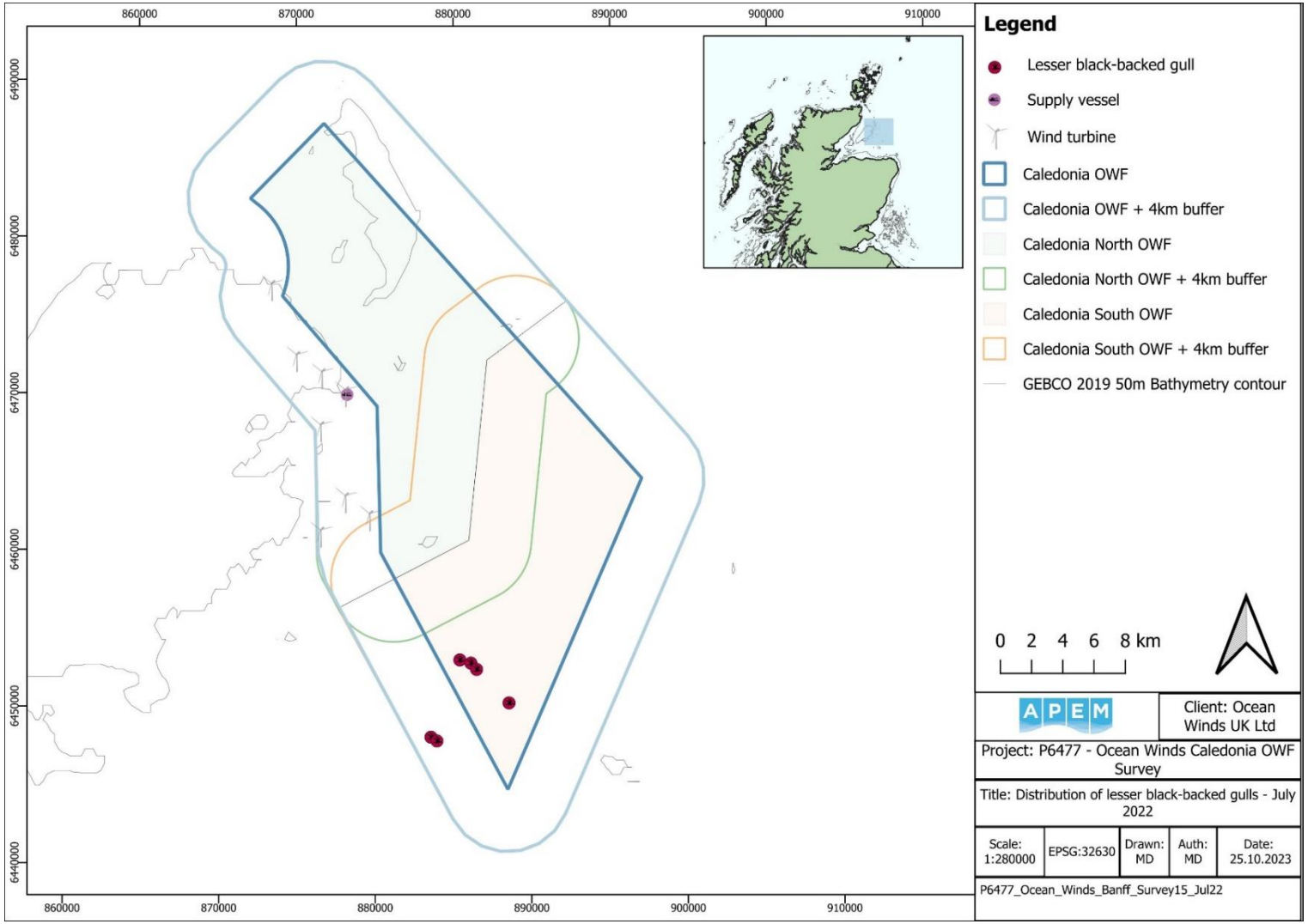



**Figure A4.110 Distribution of lesser black-backed gulls recorded in the Survey Area in July 2022**

## Unidentified black-backed gull species

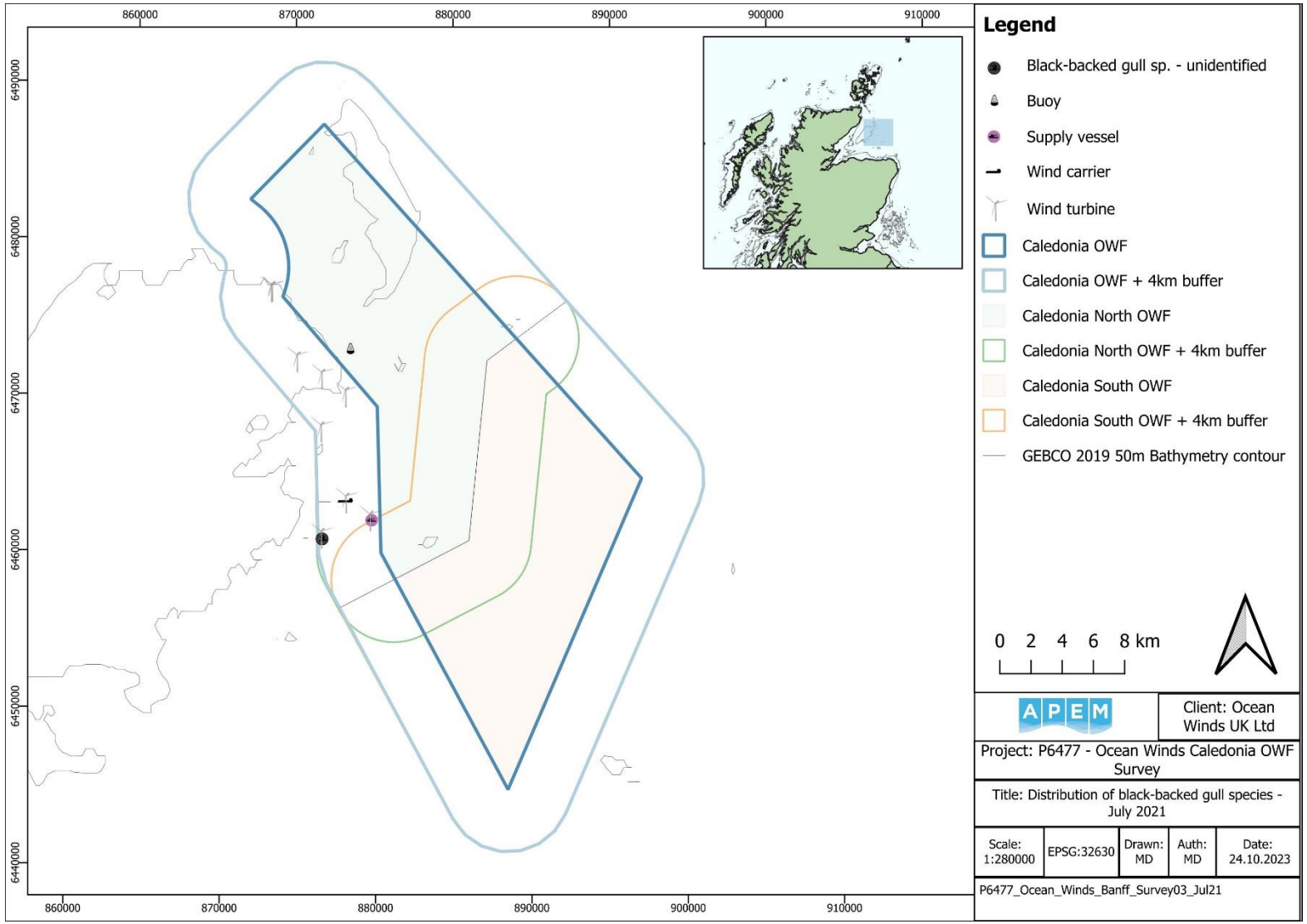



**Figure A4.111 Distribution of black-backed gull species recorded in the Survey Area in July 2021**

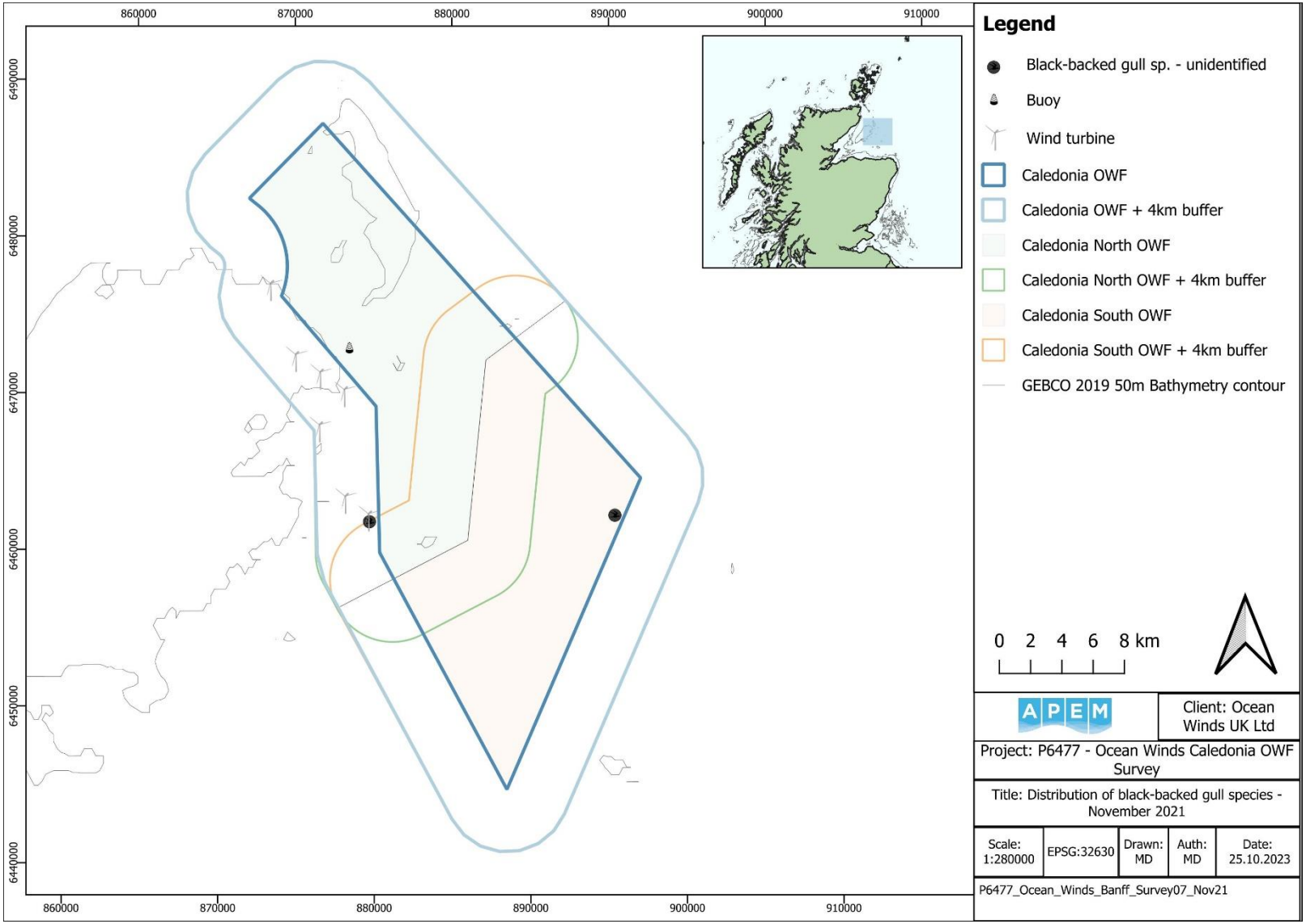



**Figure A4.112 Distribution of black-backed gull species recorded in the Survey Area in November 2021**

## Unidentified large gull species

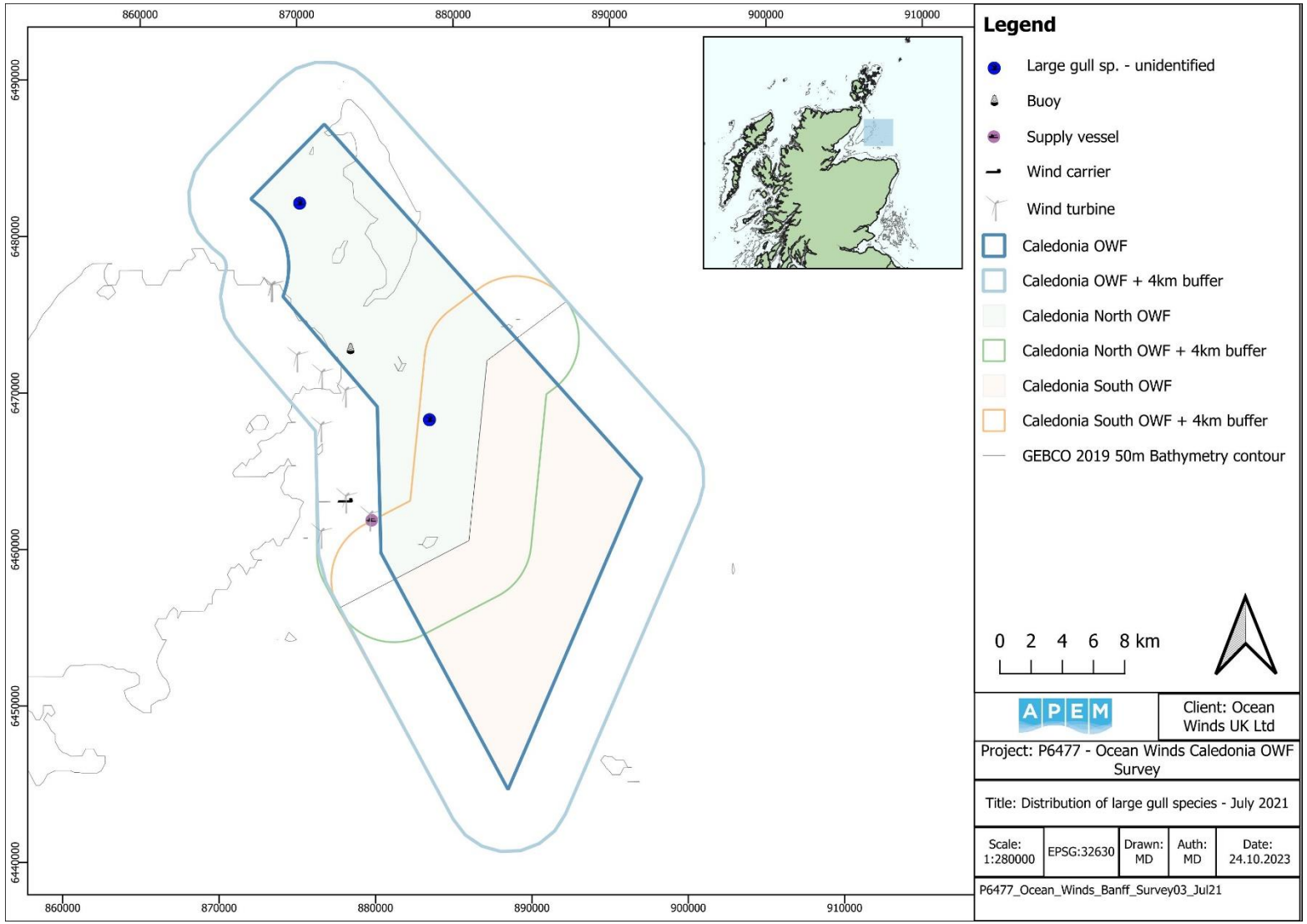



**Figure A4.113 Distribution of large gull species recorded in the Survey Area in July 2021**

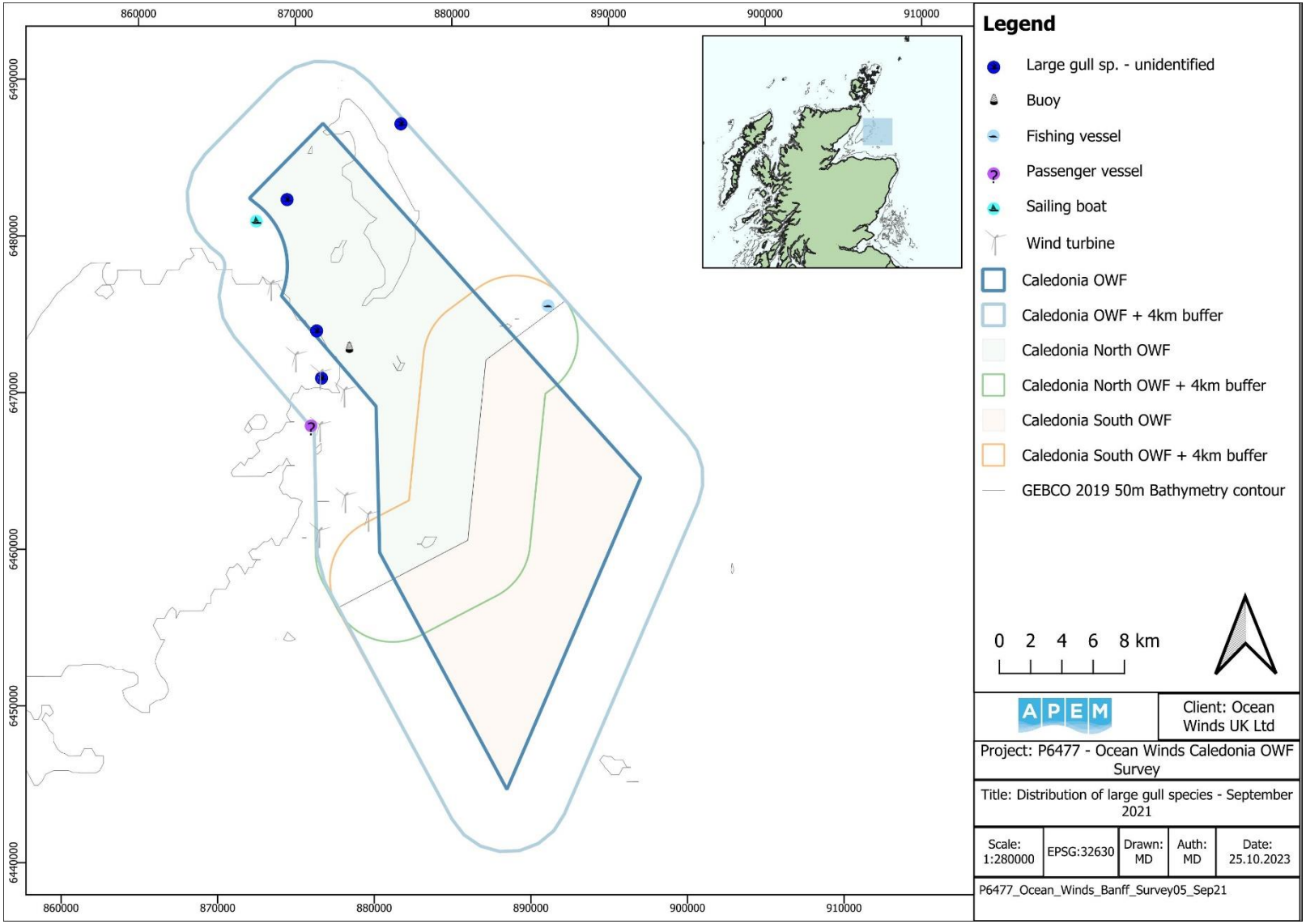



**Figure A4.114 Distribution of large gull species recorded in the Survey Area in September 2021**

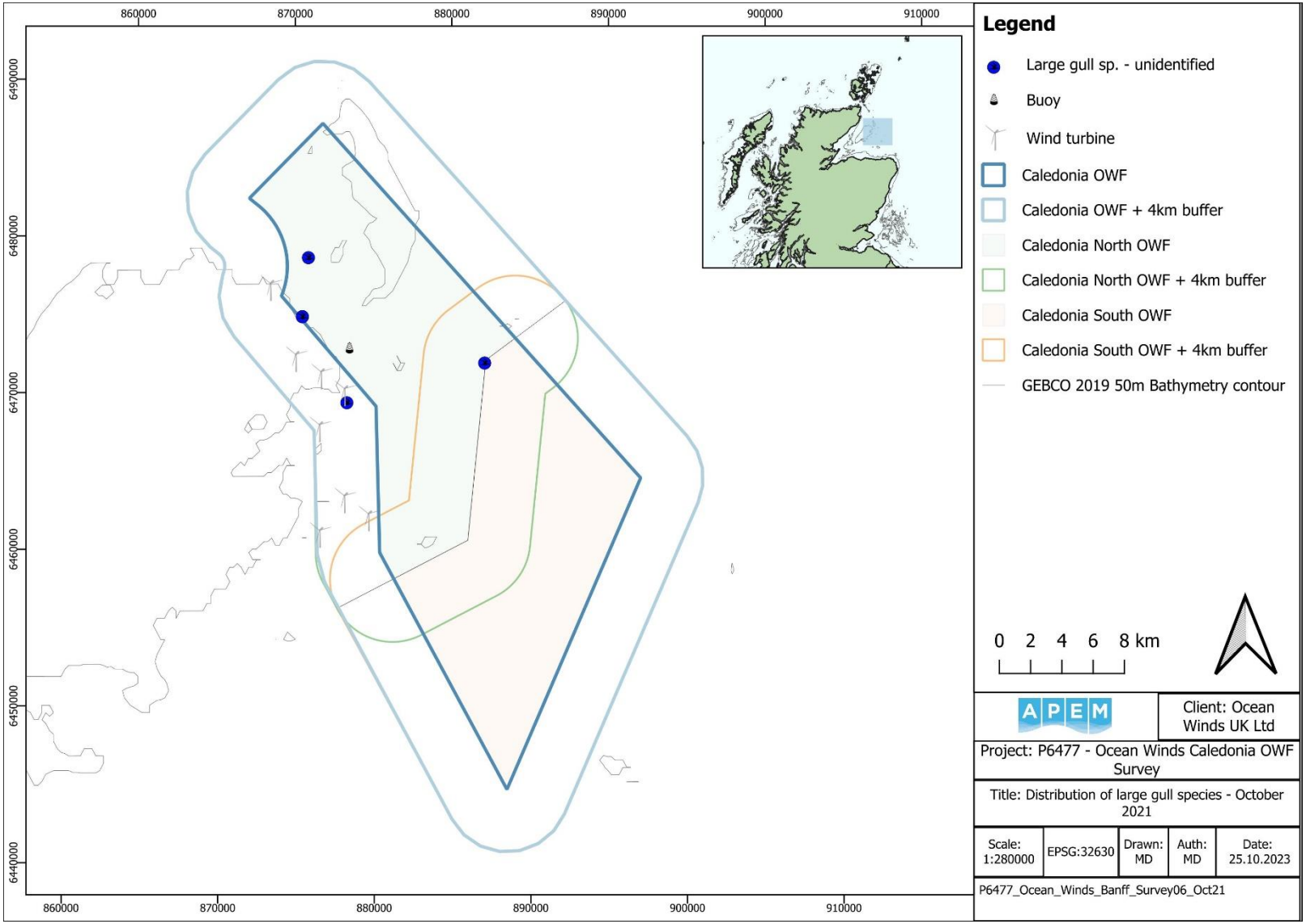



**Figure A4.115 Distribution of large gull species recorded in the Survey Area in October 2021**

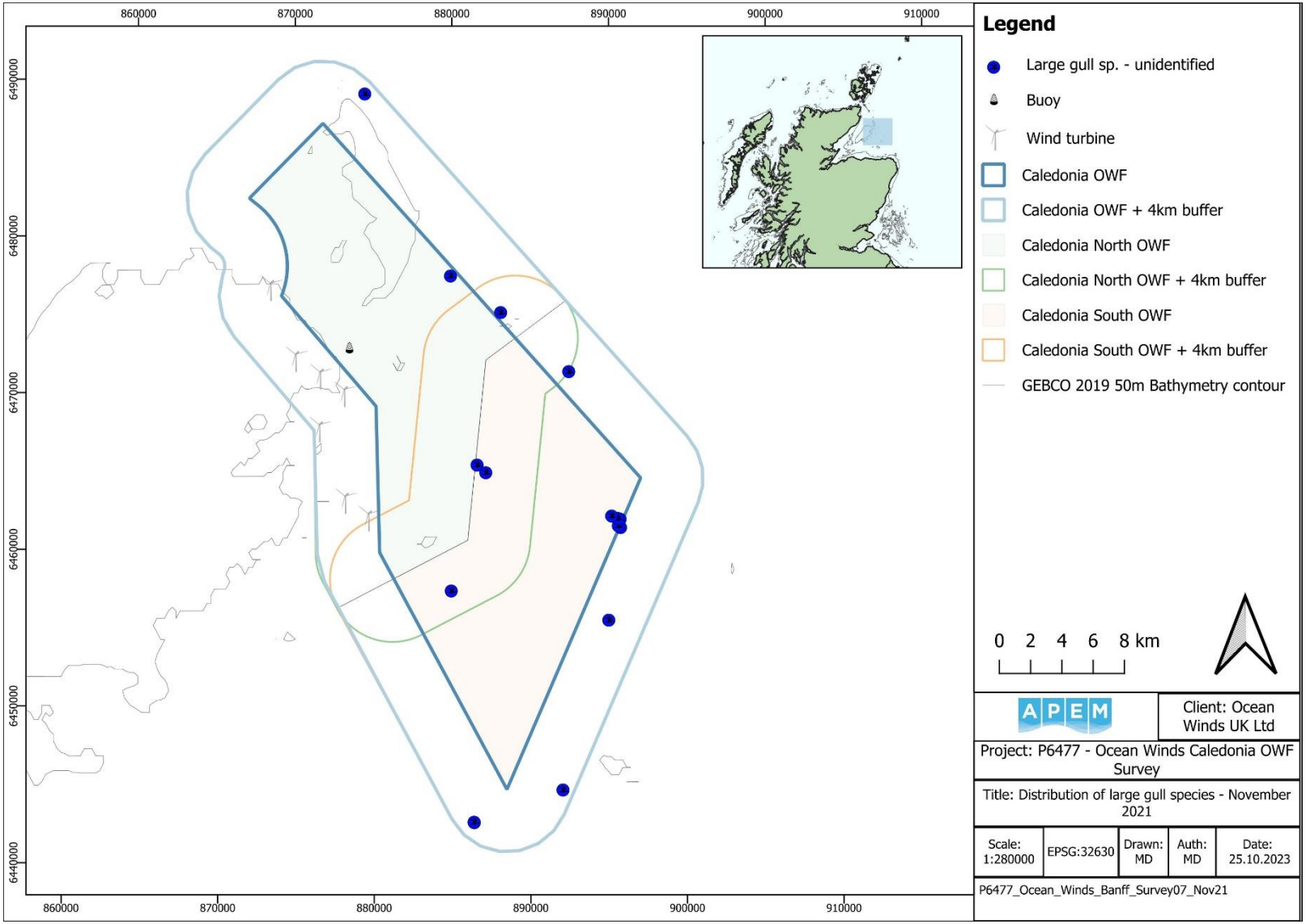



**Figure A4.116 Distribution of large gull species recorded in the Survey Area in November 2021**

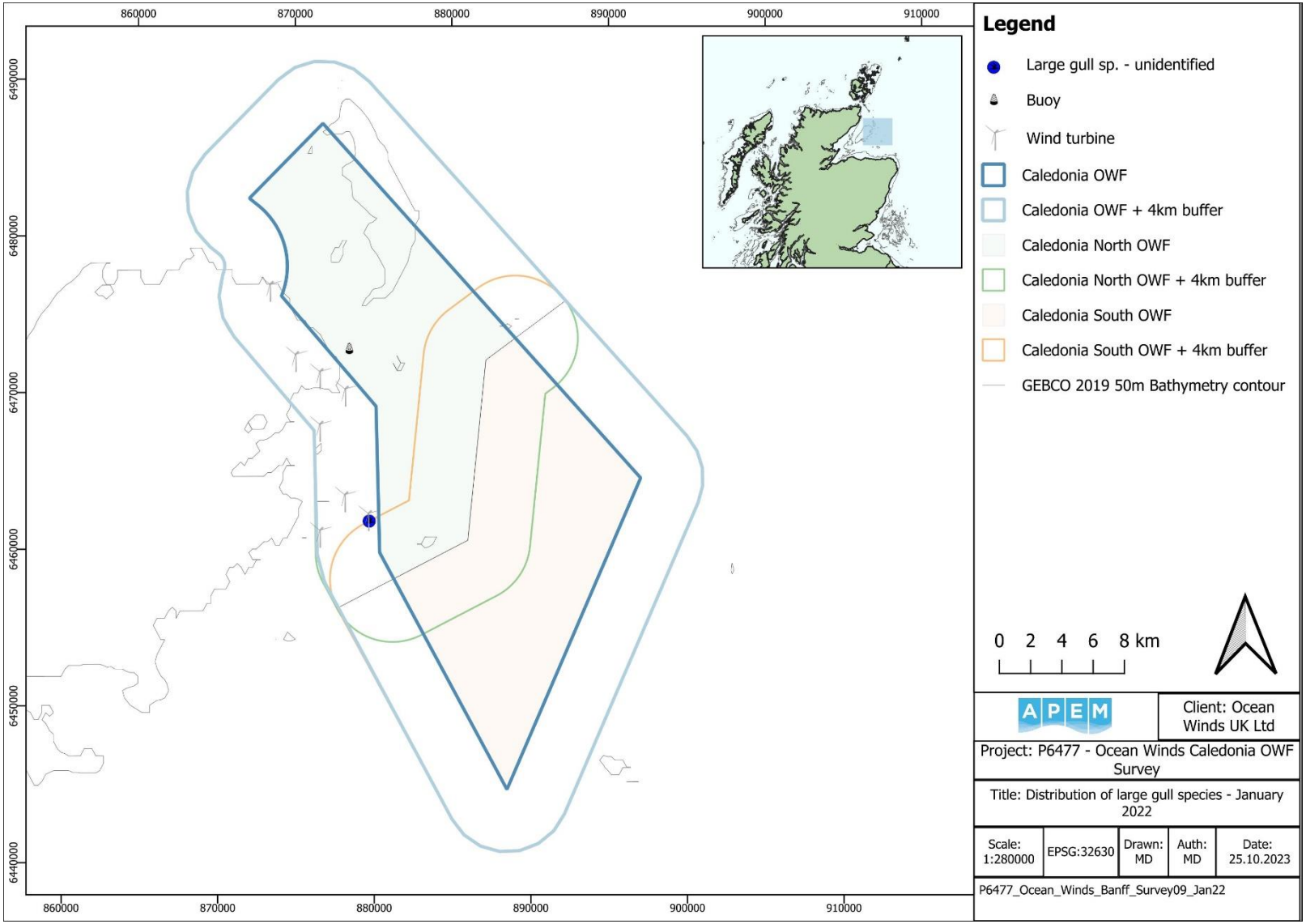



**Figure A4.117 Distribution of large gull species recorded in the Survey Area in January 2022**

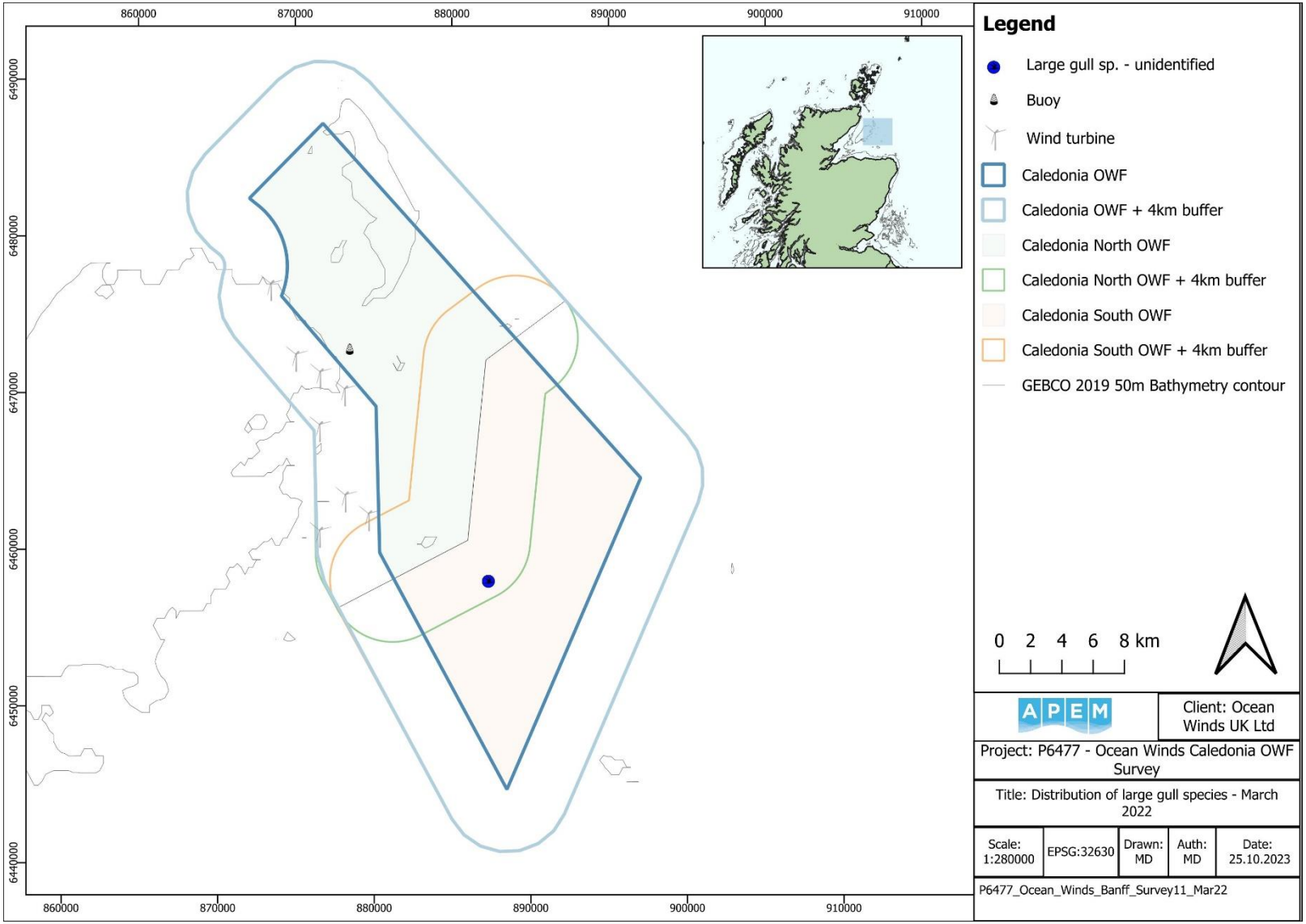



**Figure A4.118 Distribution of large gull species recorded in the Survey Area in March 2022**

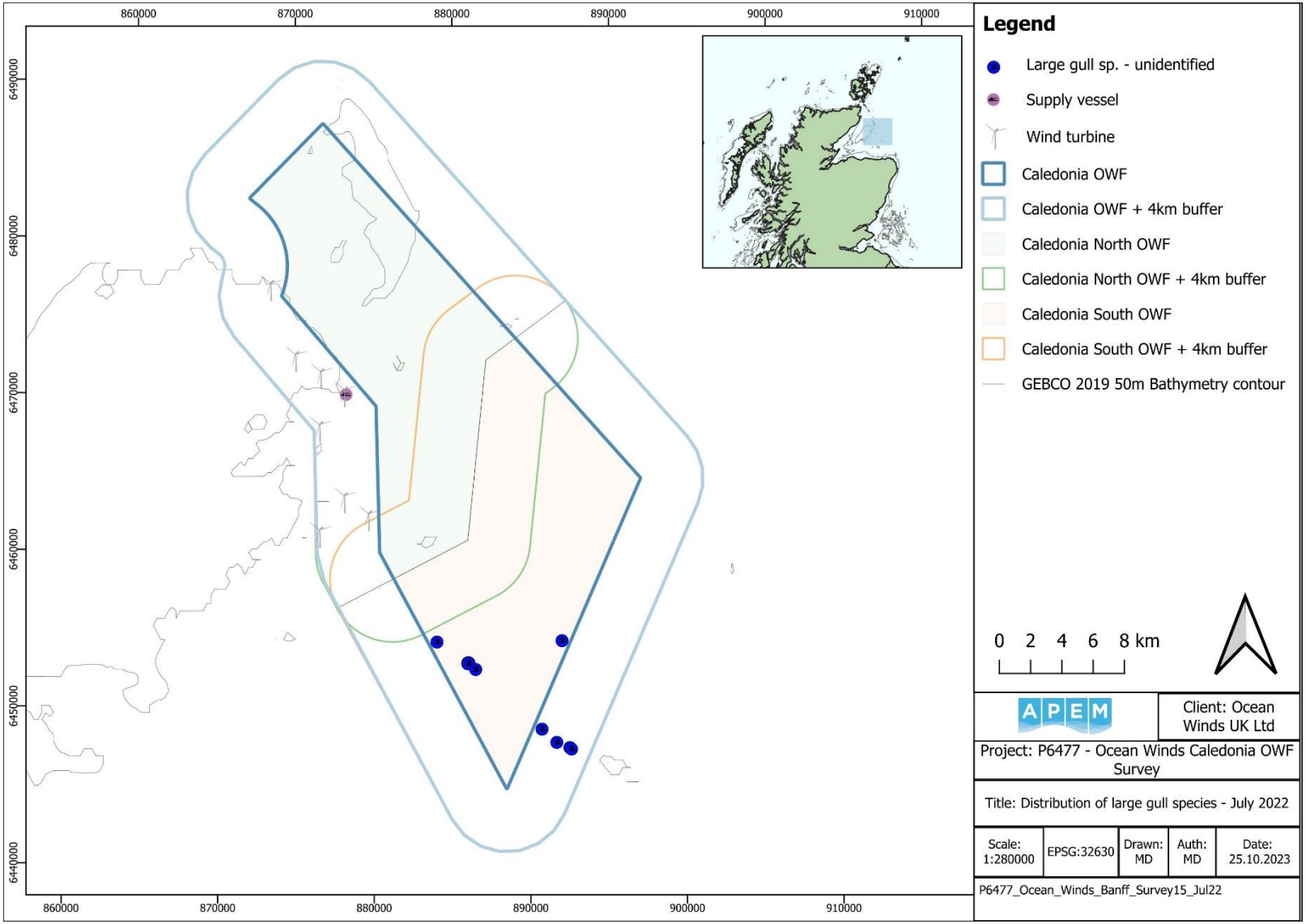



**Figure A4.119 Distribution of large gull species recorded in the Survey Area in July 2022**

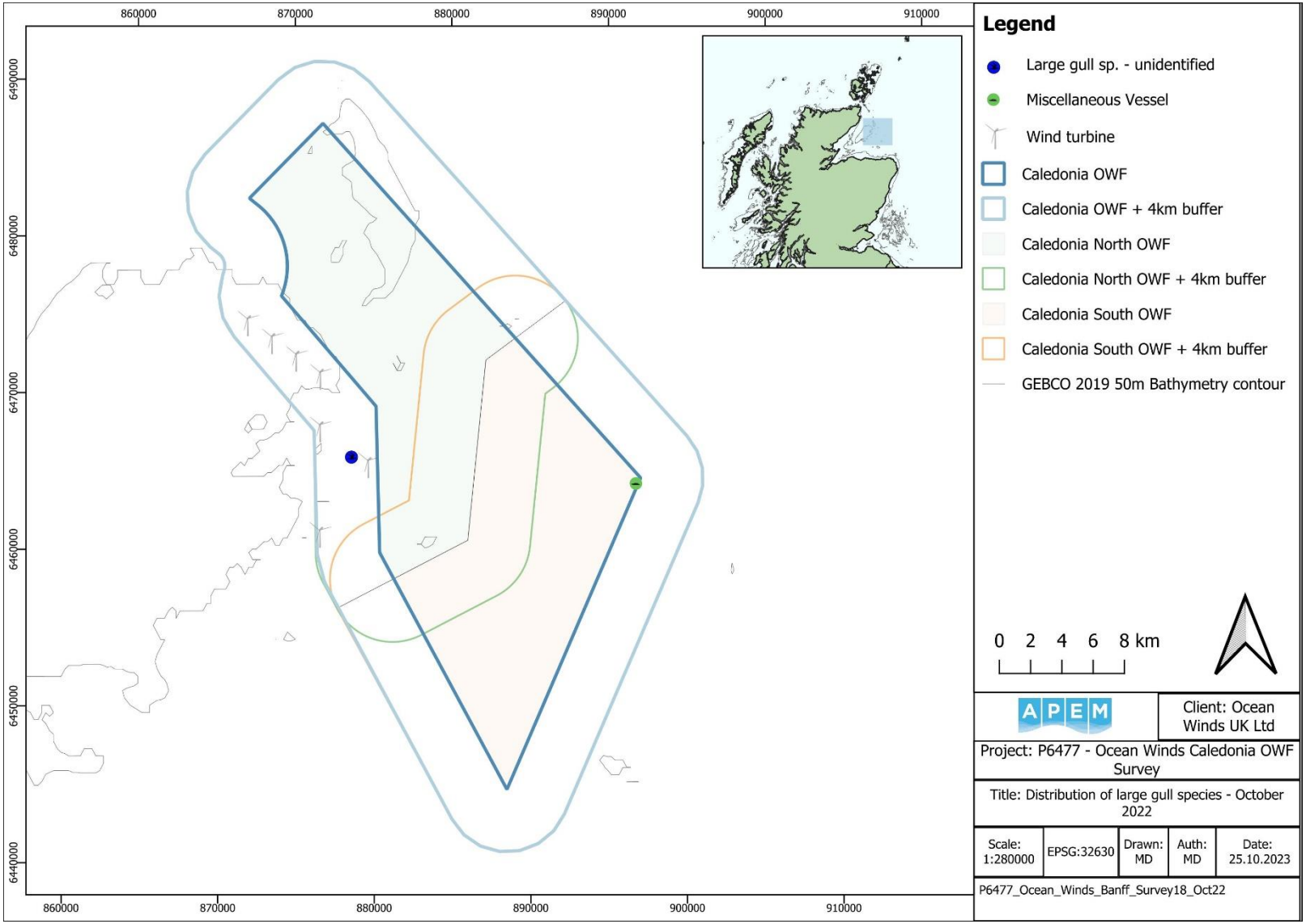



**Figure A4.120 Distribution of large gull species recorded in the Survey Area in October 2022**

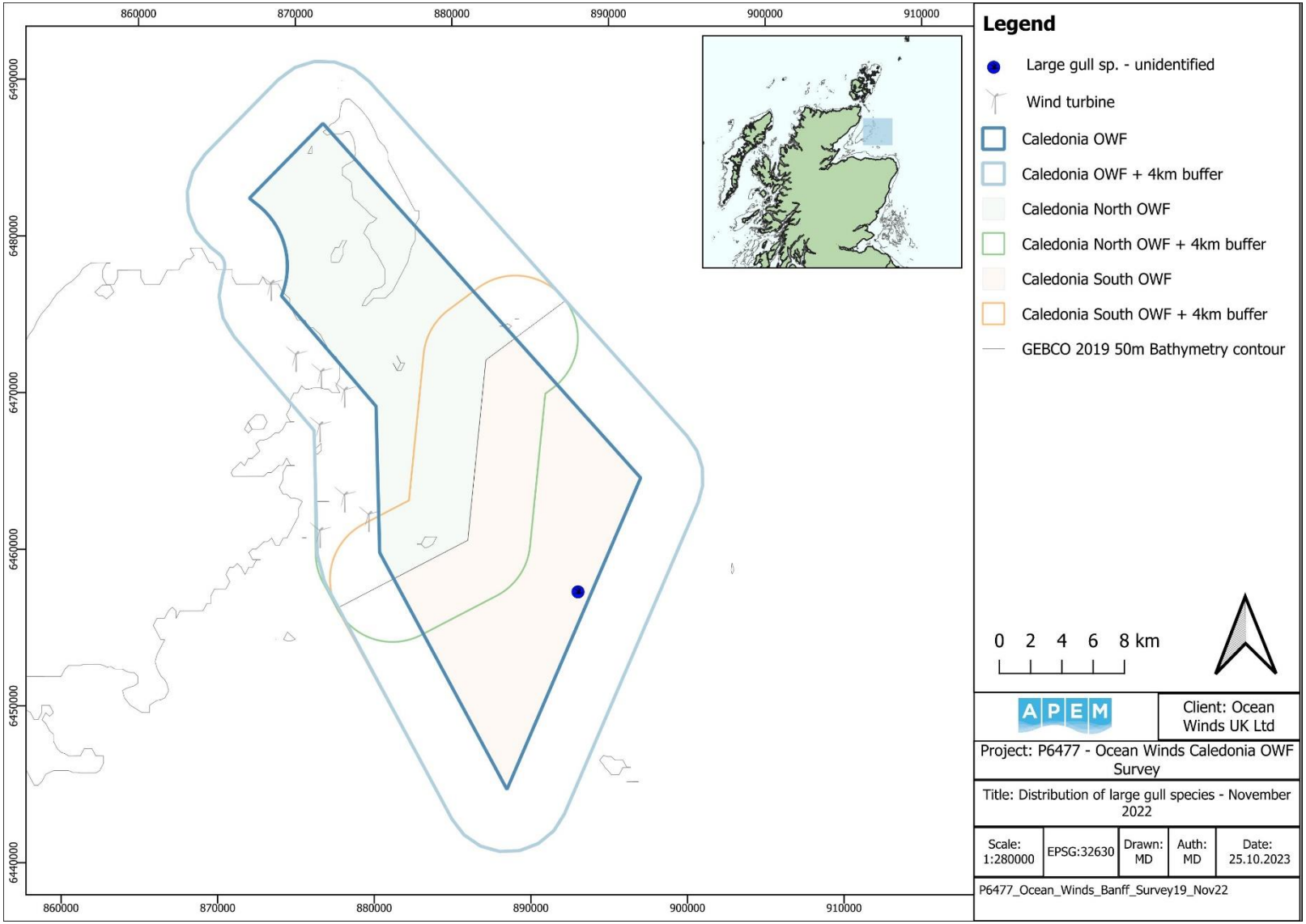



**Figure A4.121 Distribution of large gull species recorded in the Survey Area in November 2022**

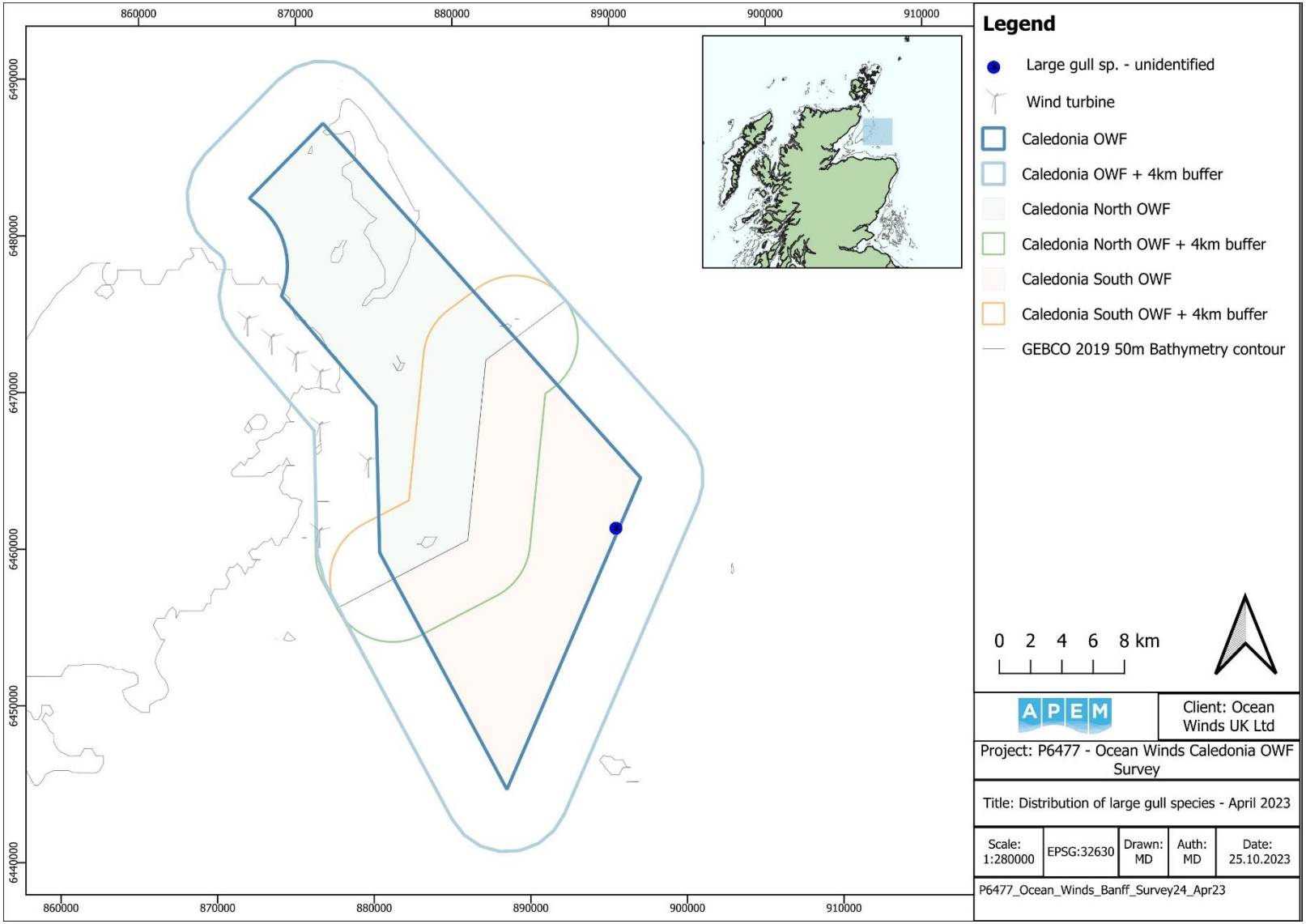



**Figure A4.122 Distribution of large gull species recorded in the Survey Area in April 2023**

## Unidentified gull species

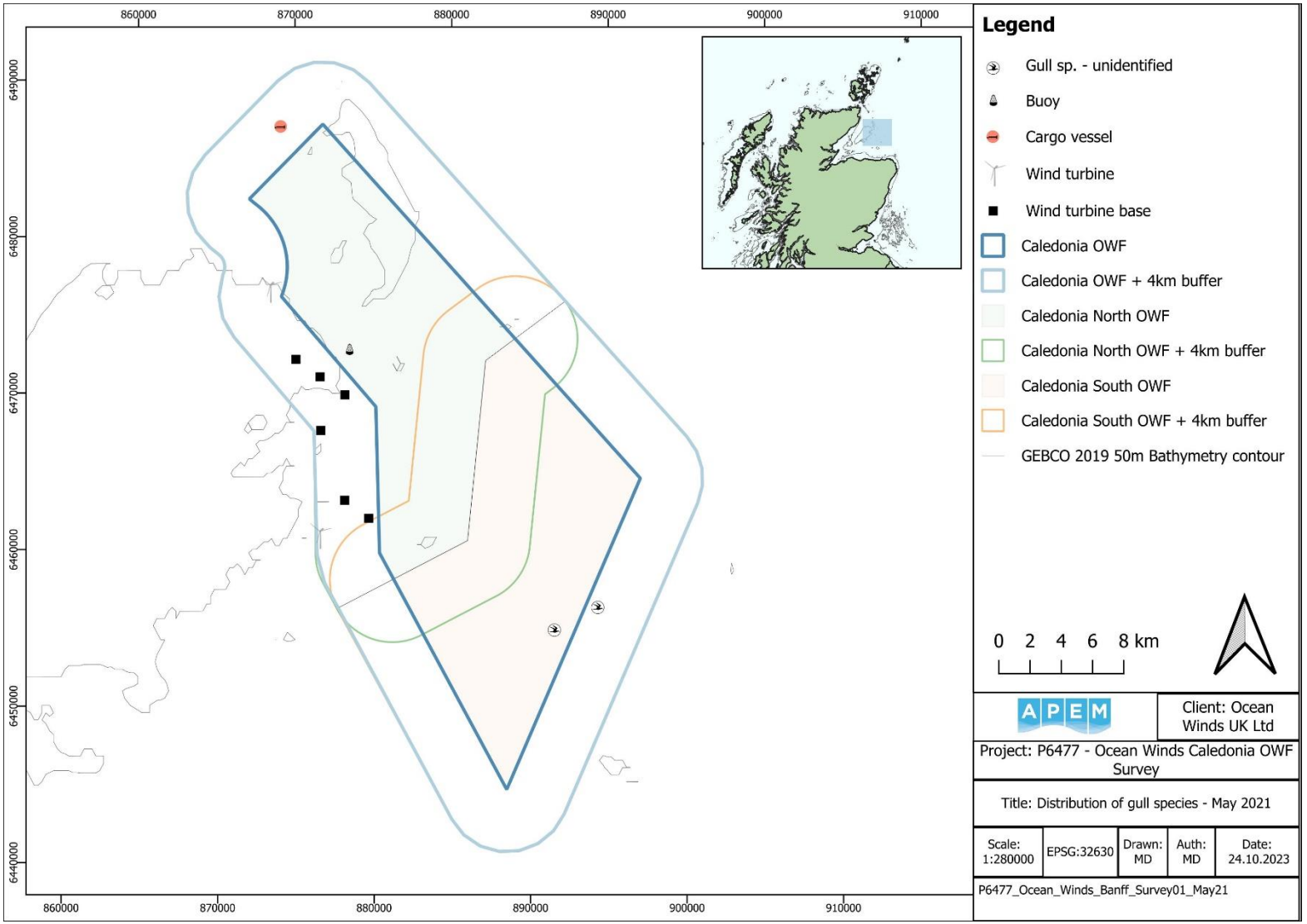



**Figure A4.123 Distribution of gull species recorded in the Survey Area in May 2021**

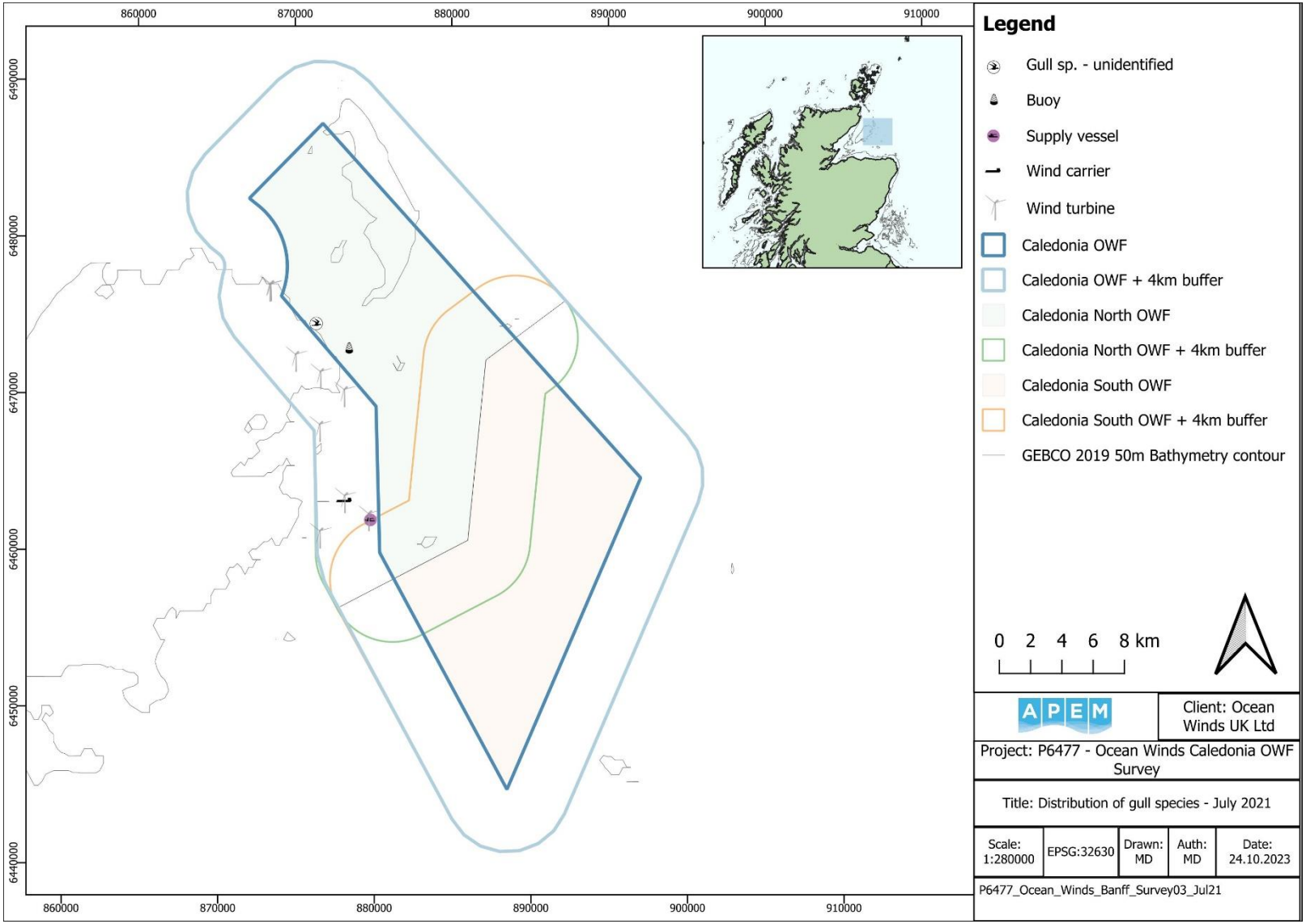



**Figure A4.124 Distribution of gull species recorded in the Survey Area in July 2021**

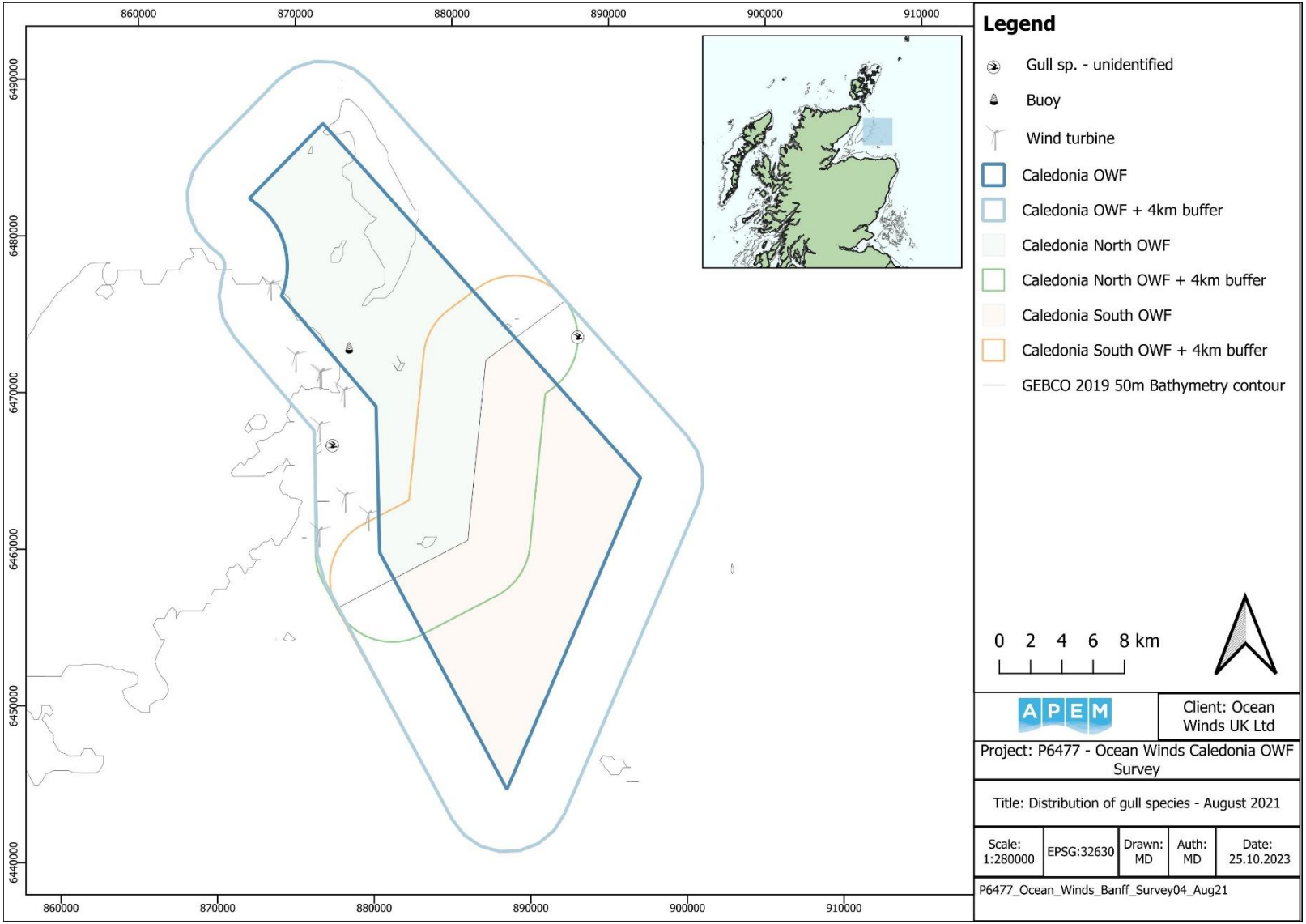



**Figure A4.125 Distribution of gull species recorded in the Survey Area in August 2021**

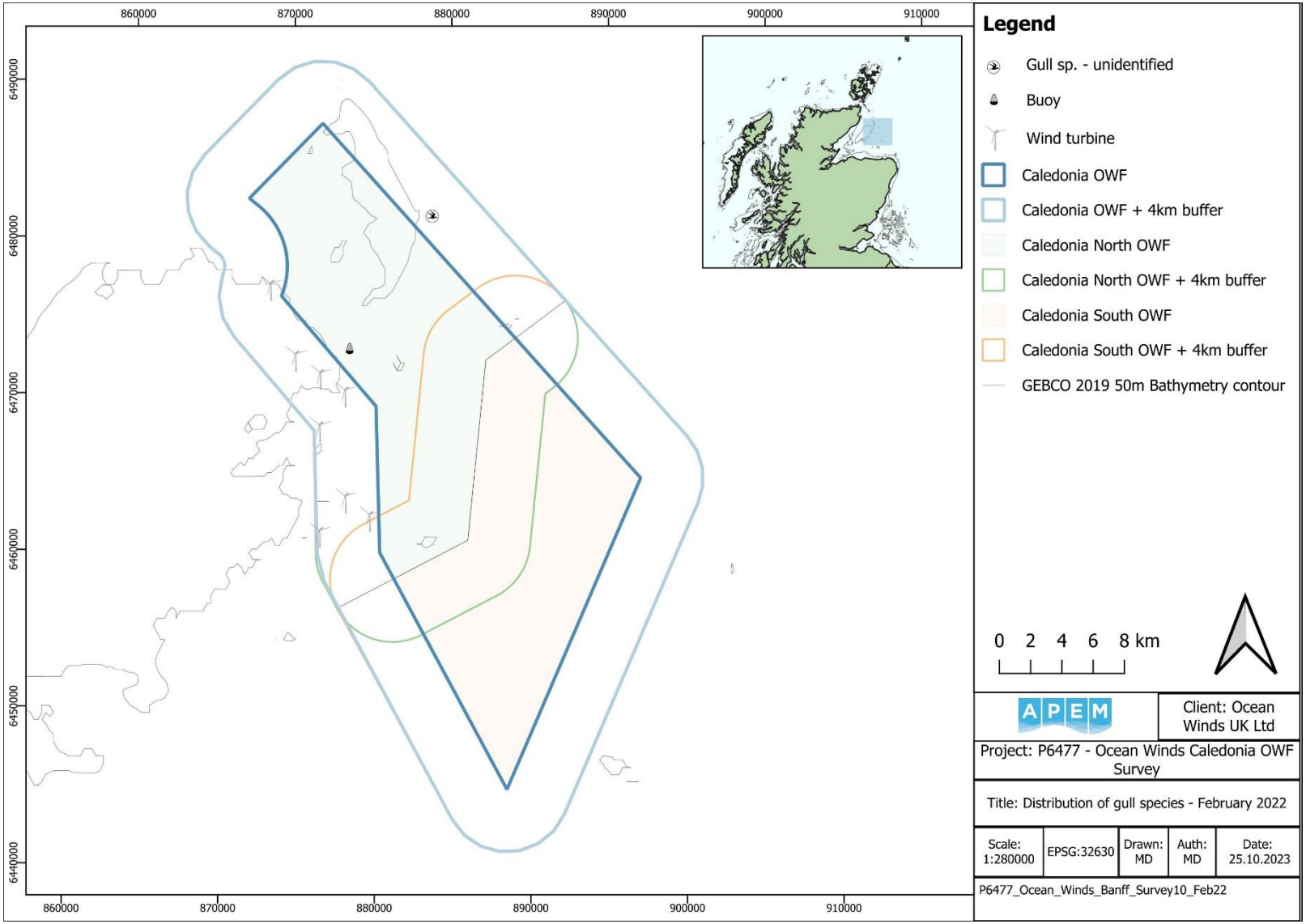



**Figure A4.126 Distribution of gull species recorded in the Survey Area in February 2022**

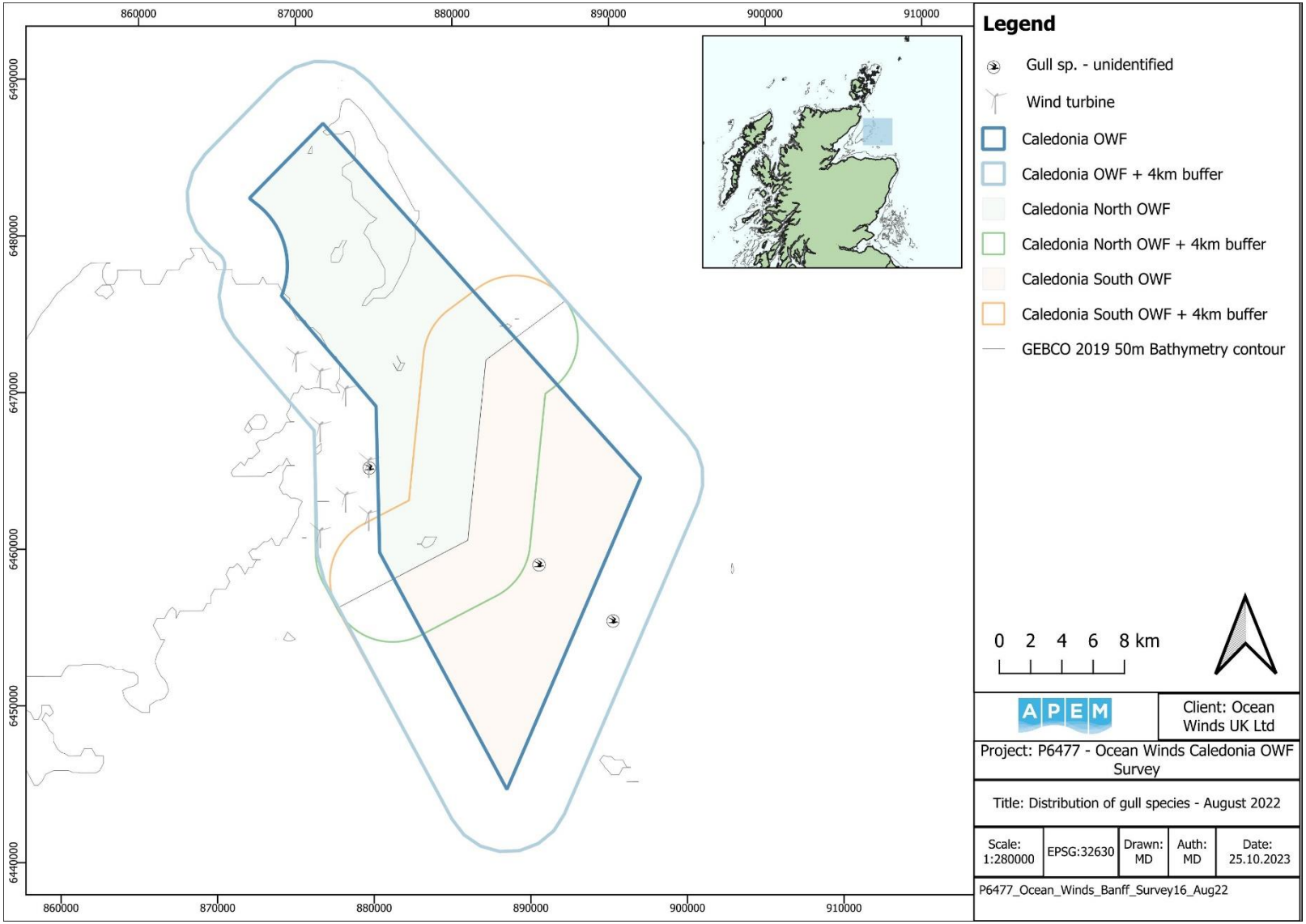



**Figure A4.127 Distribution of gull species recorded in the Survey Area in August 2022**

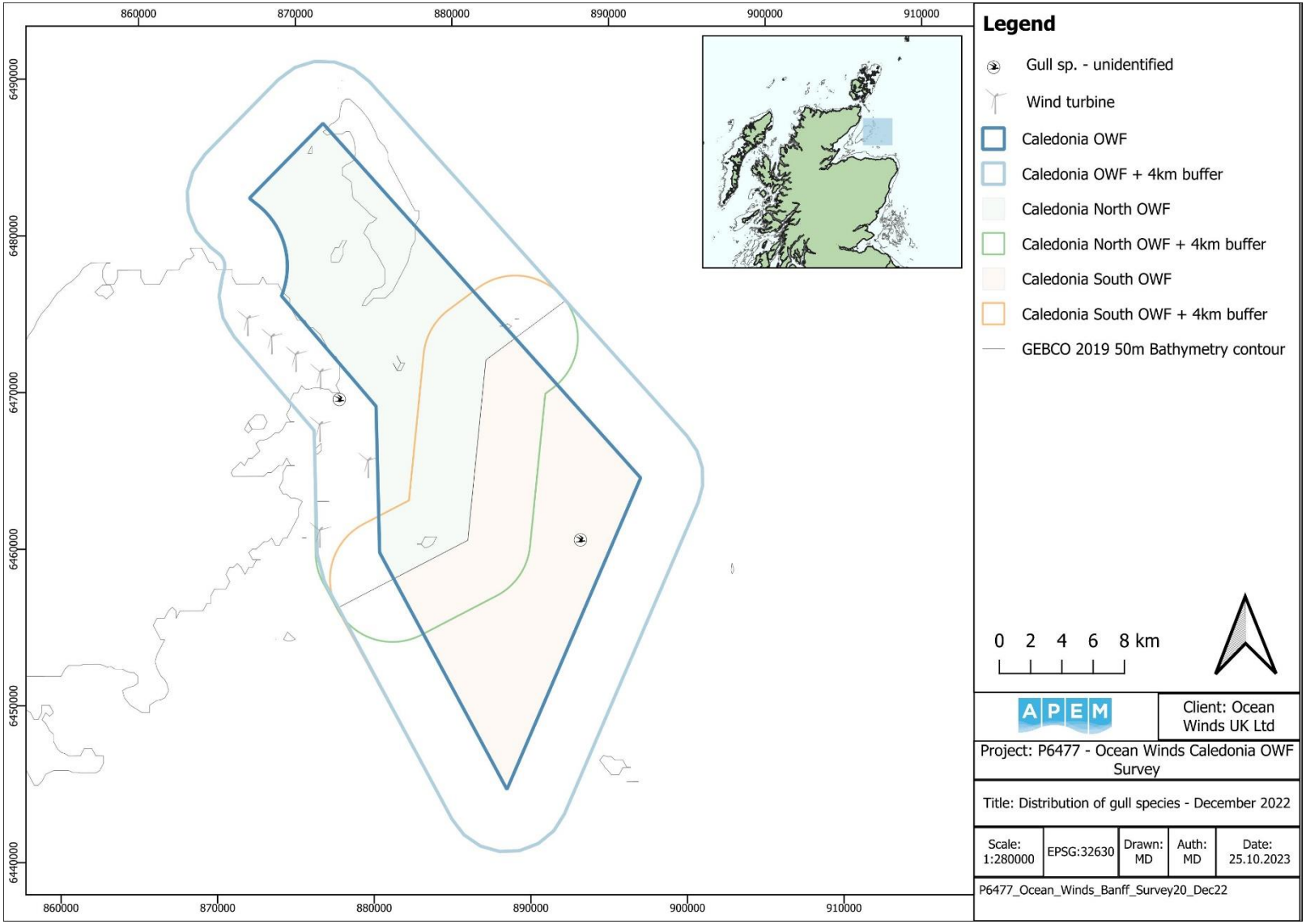



**Figure A4.128 Distribution of gull species recorded in the Survey Area in December 2022**

## Common tern

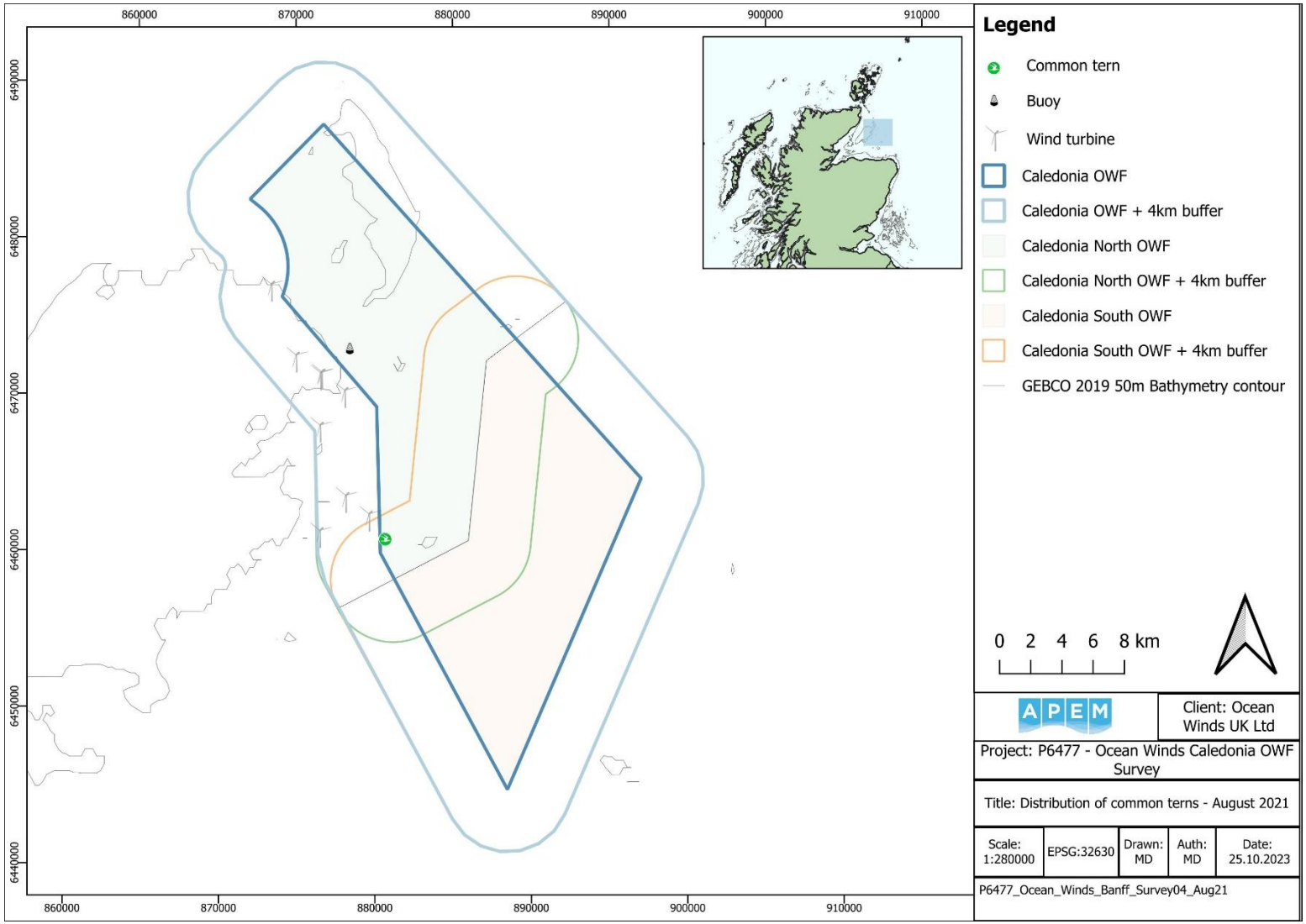



**Figure A4.129 Distribution of common terns recorded in the Survey Area in August 2021**

## Arctic tern

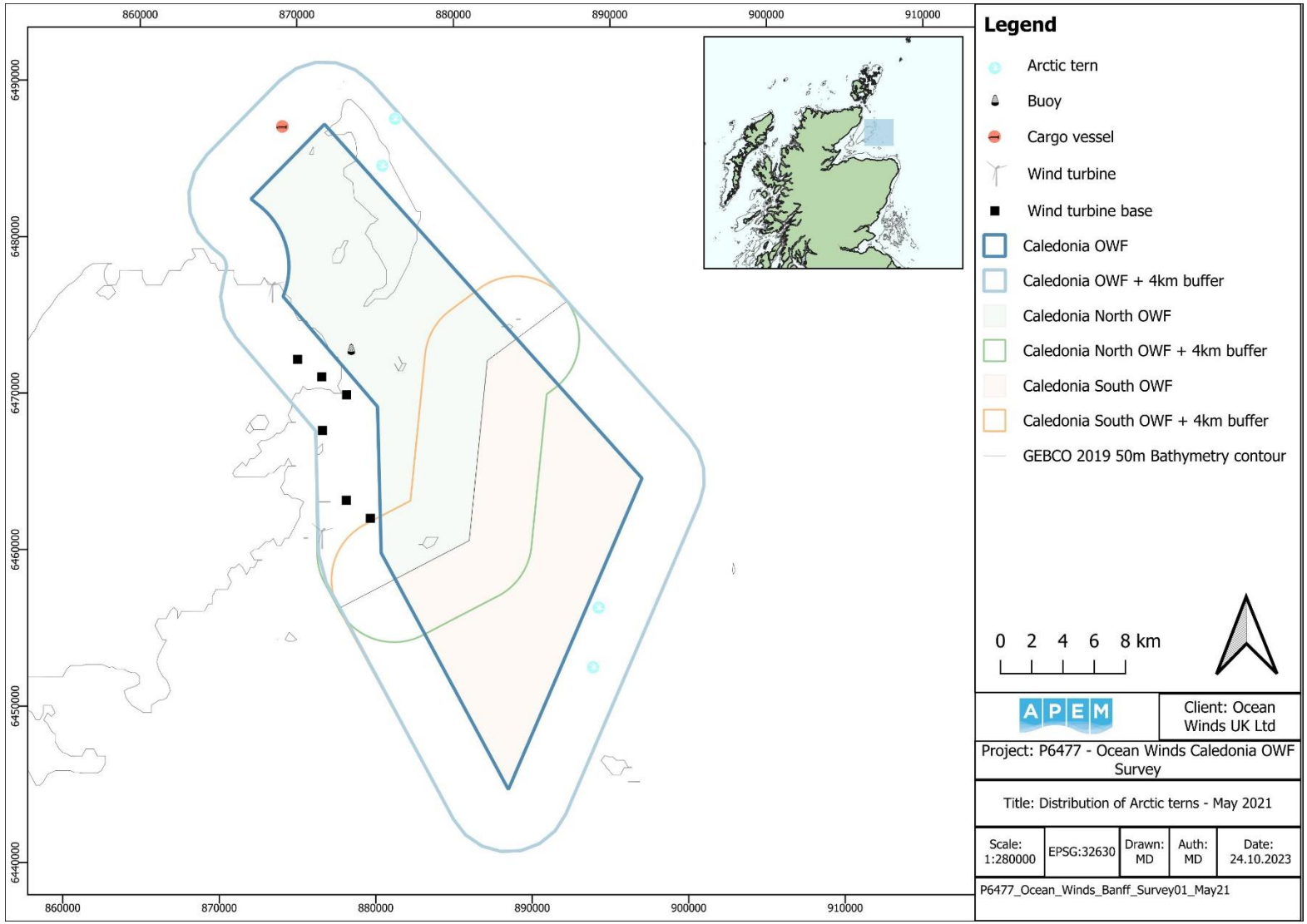



**Figure A4.130 Distribution of Arctic terns recorded in the Survey Area in May 2021**

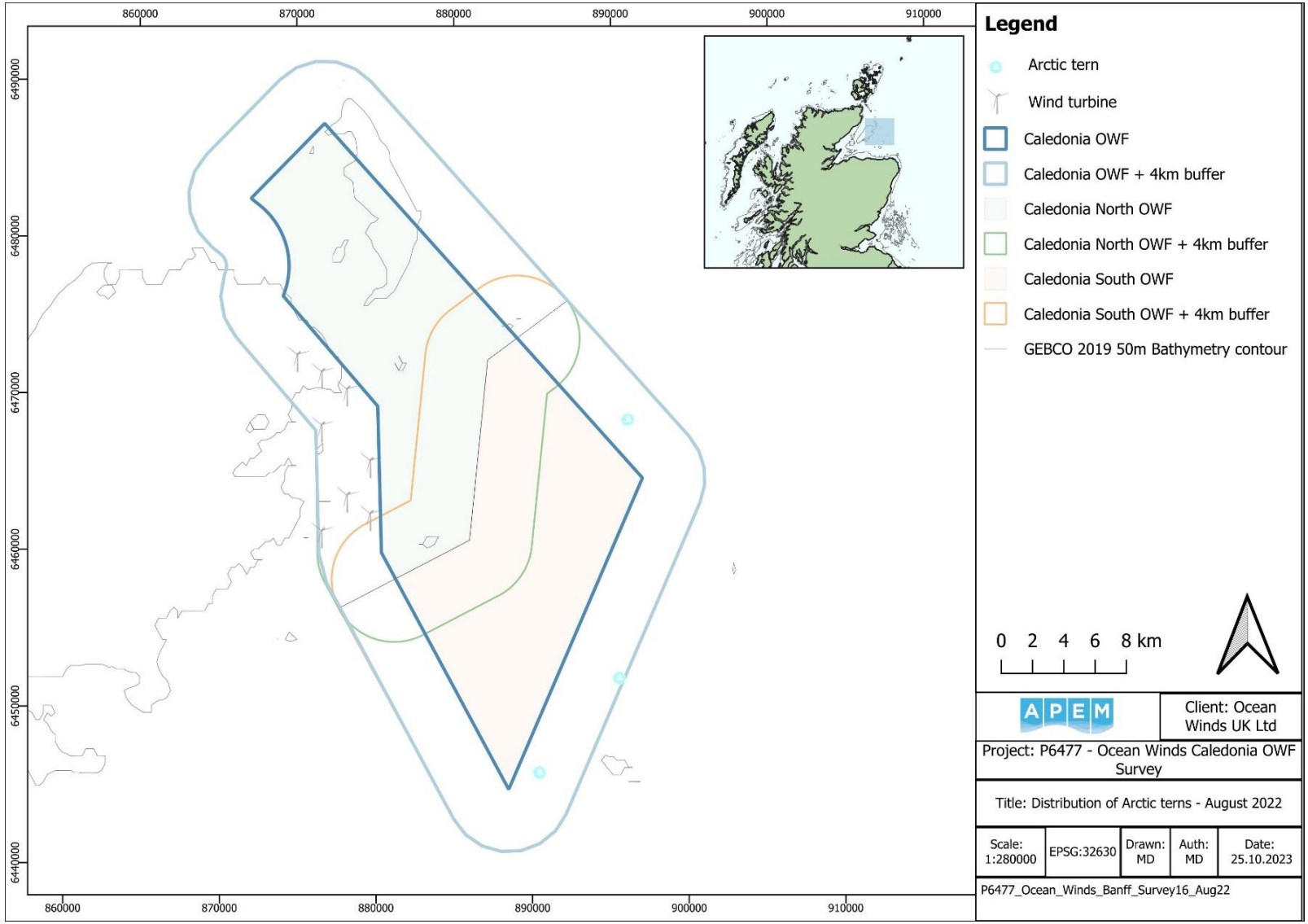



**Figure A4.131 Distribution of Arctic terns recorded in the Survey Area in August 2022**

### 'Commic' tern

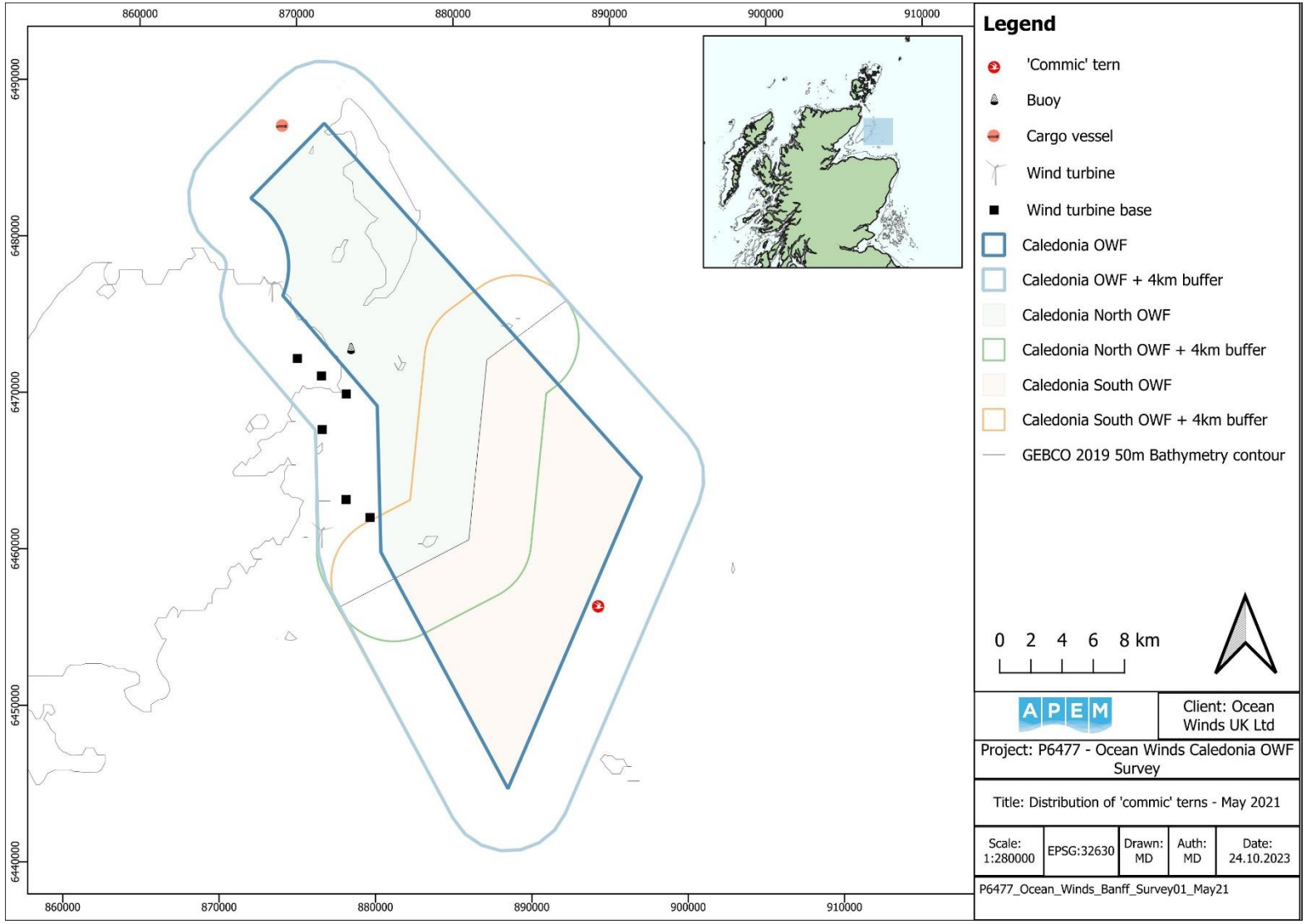



**Figure A4.132 Distribution of 'commic' terns recorded in the Survey Area in May 2021**

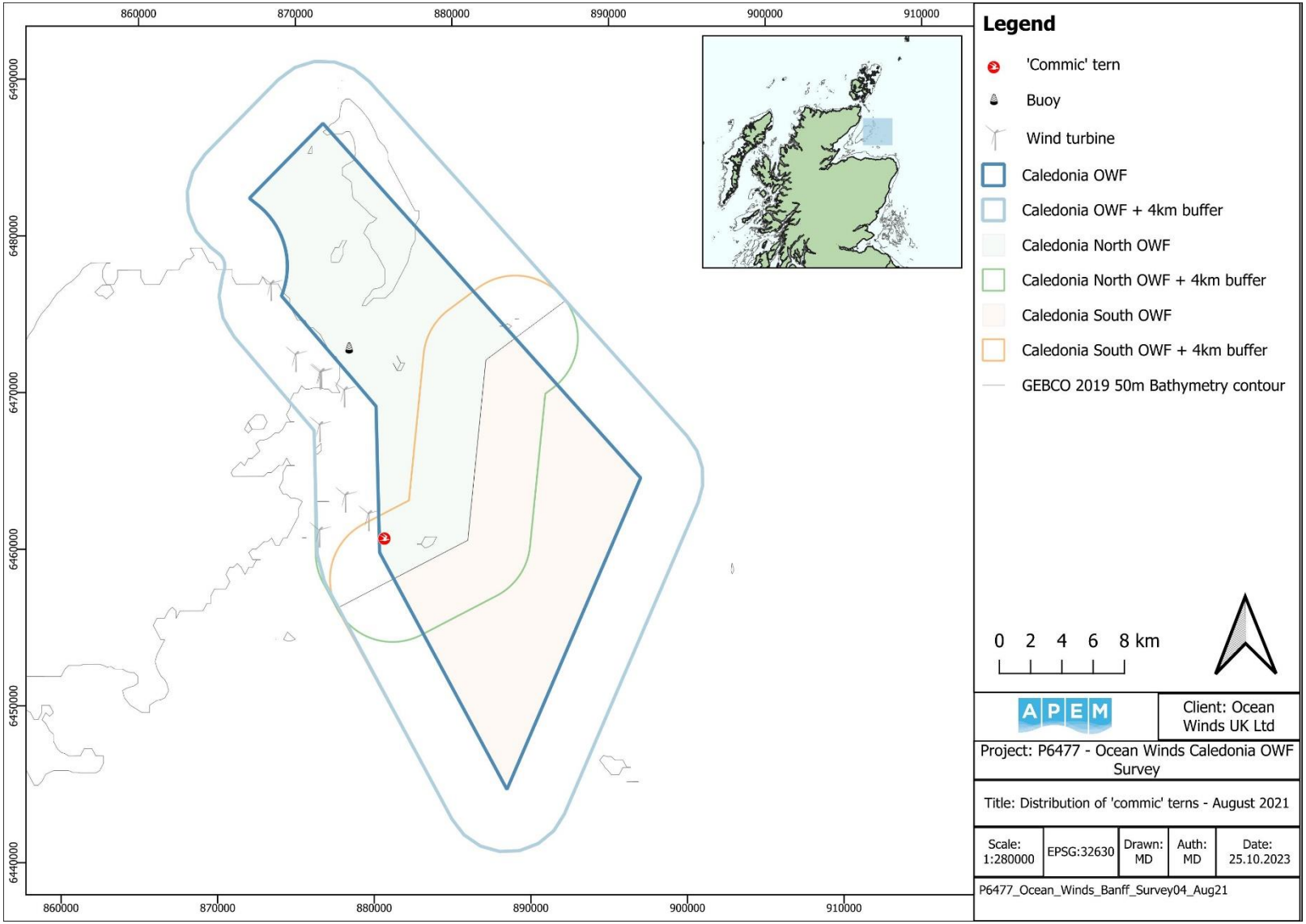



**Figure A4.133 Distribution of 'commic' terns recorded in the Survey Area in August 2021**

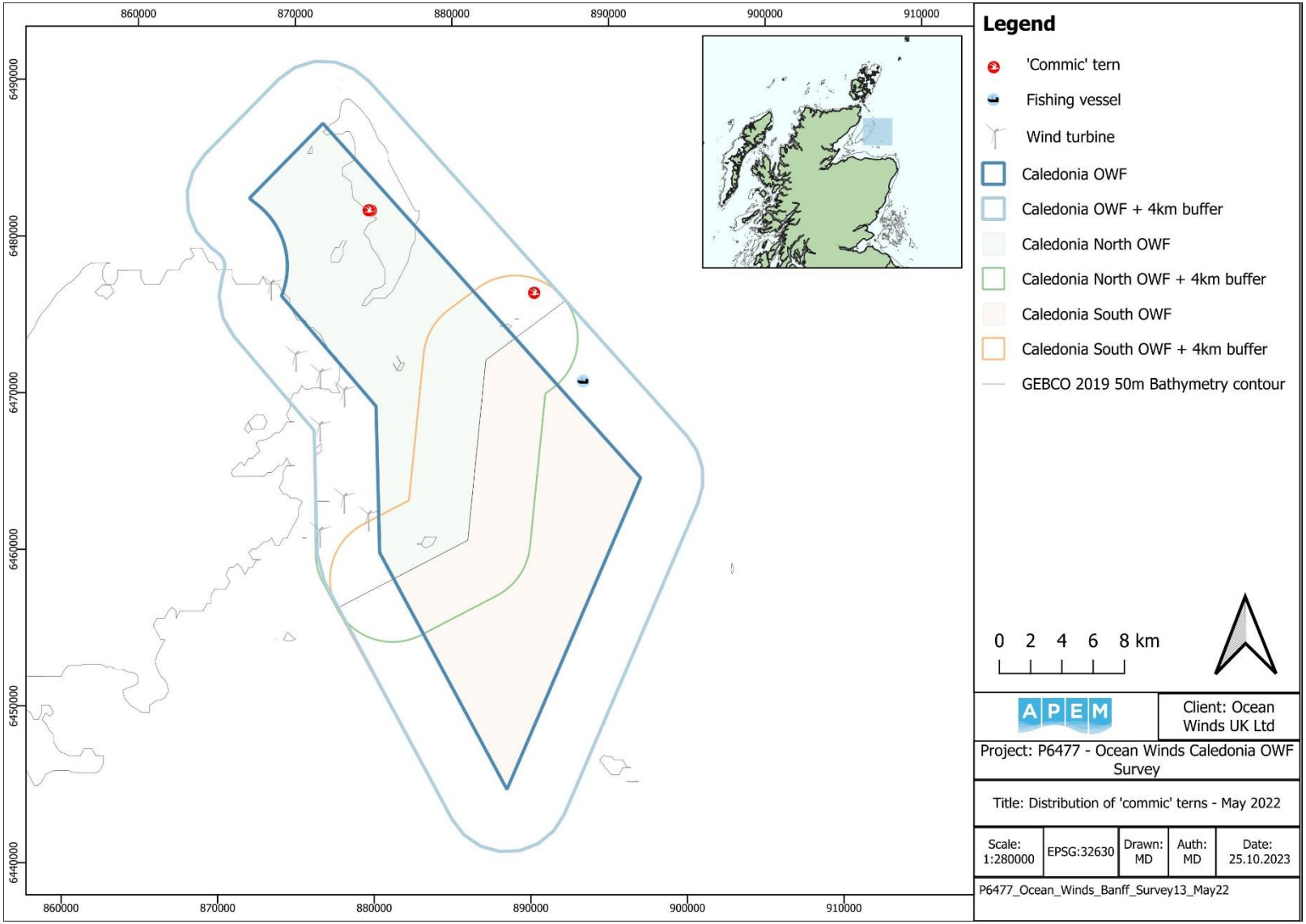



**Figure A4.134 Distribution of 'commic' terns recorded in the Survey Area in May 2022**

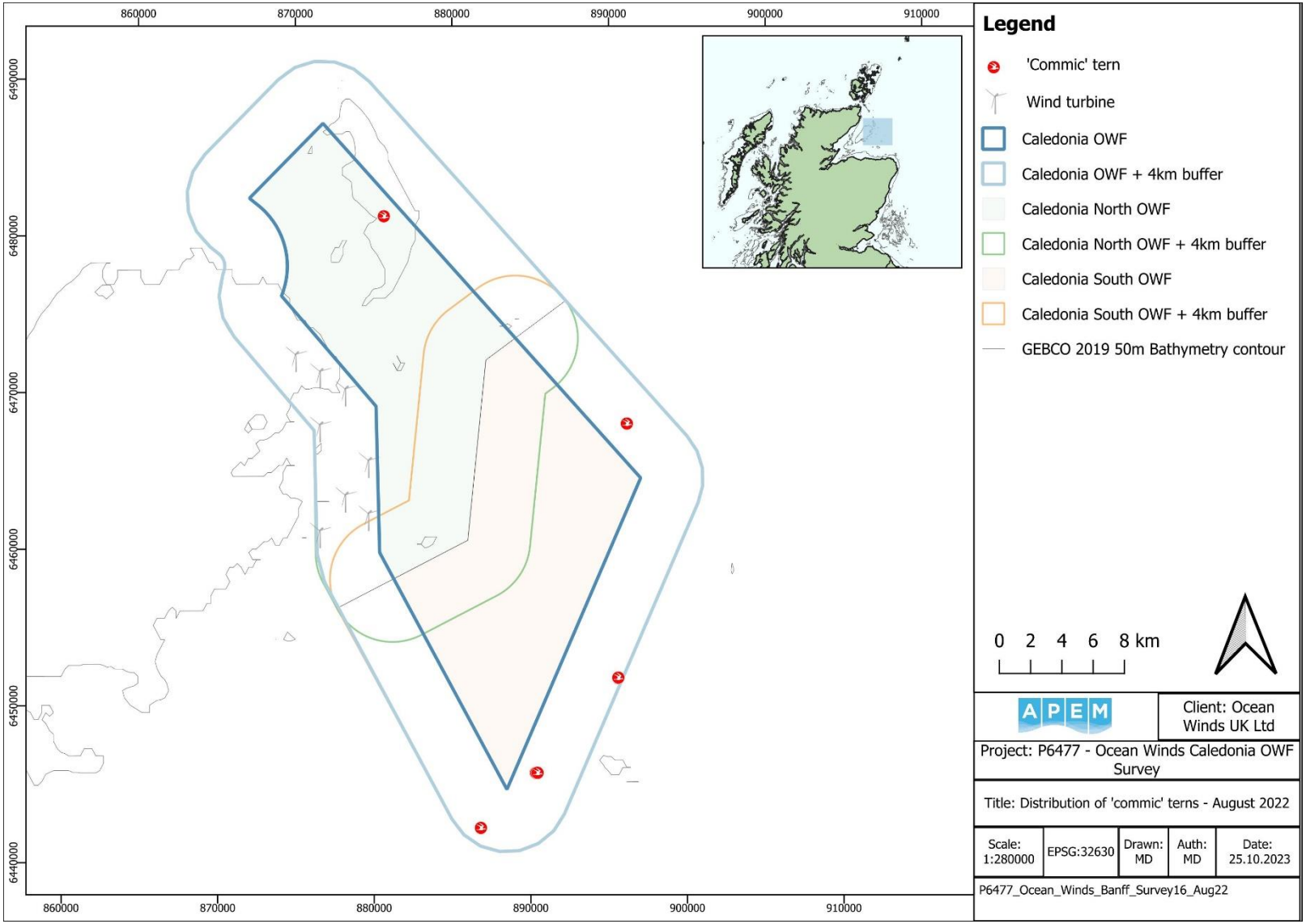



**Figure A4.135 Distribution of 'commic' terns recorded in the Survey Area in August 2022**

### Unidentified tern species

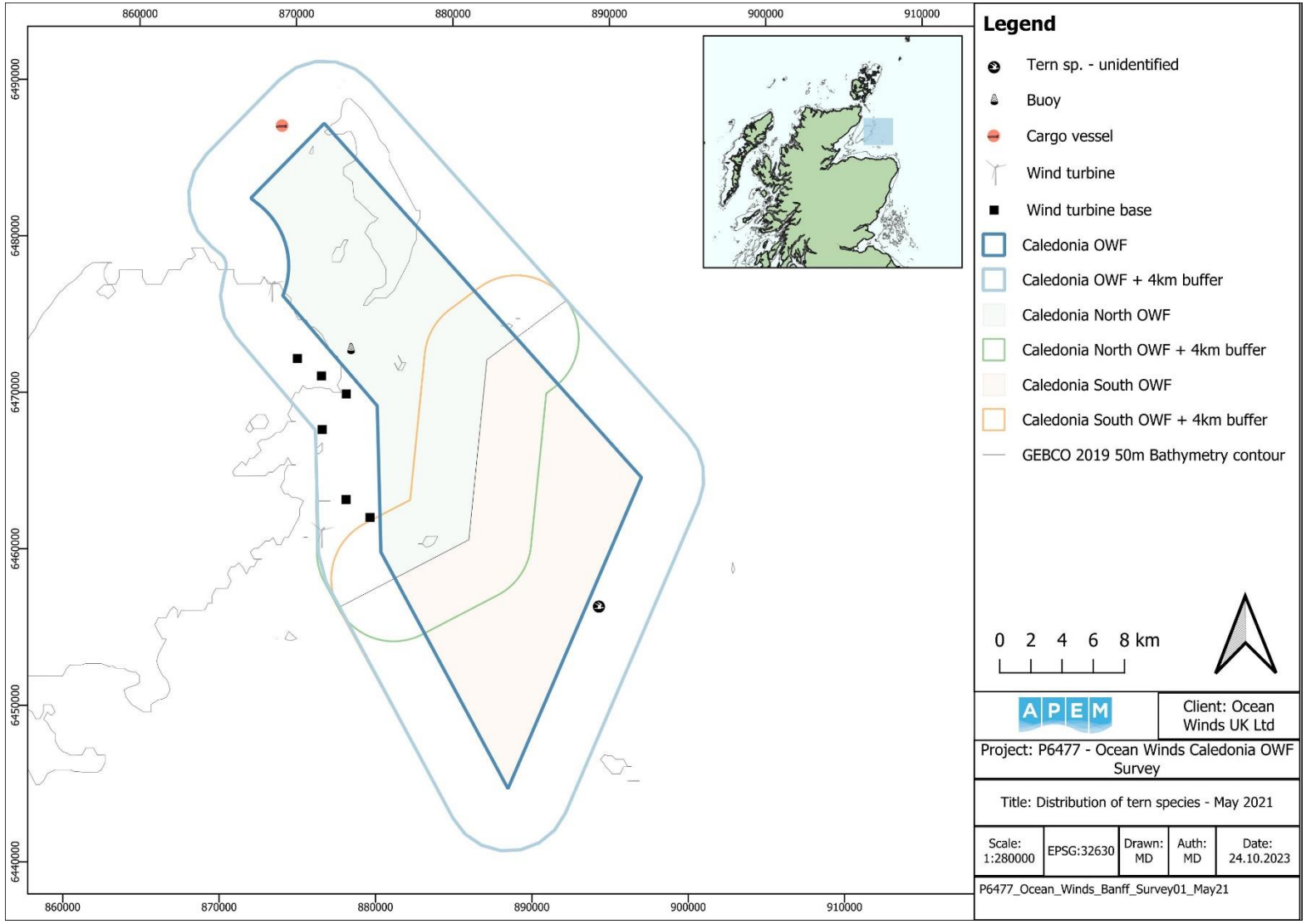



**Figure A4.136 Distribution of tern species recorded in the Survey Area in May 2021**

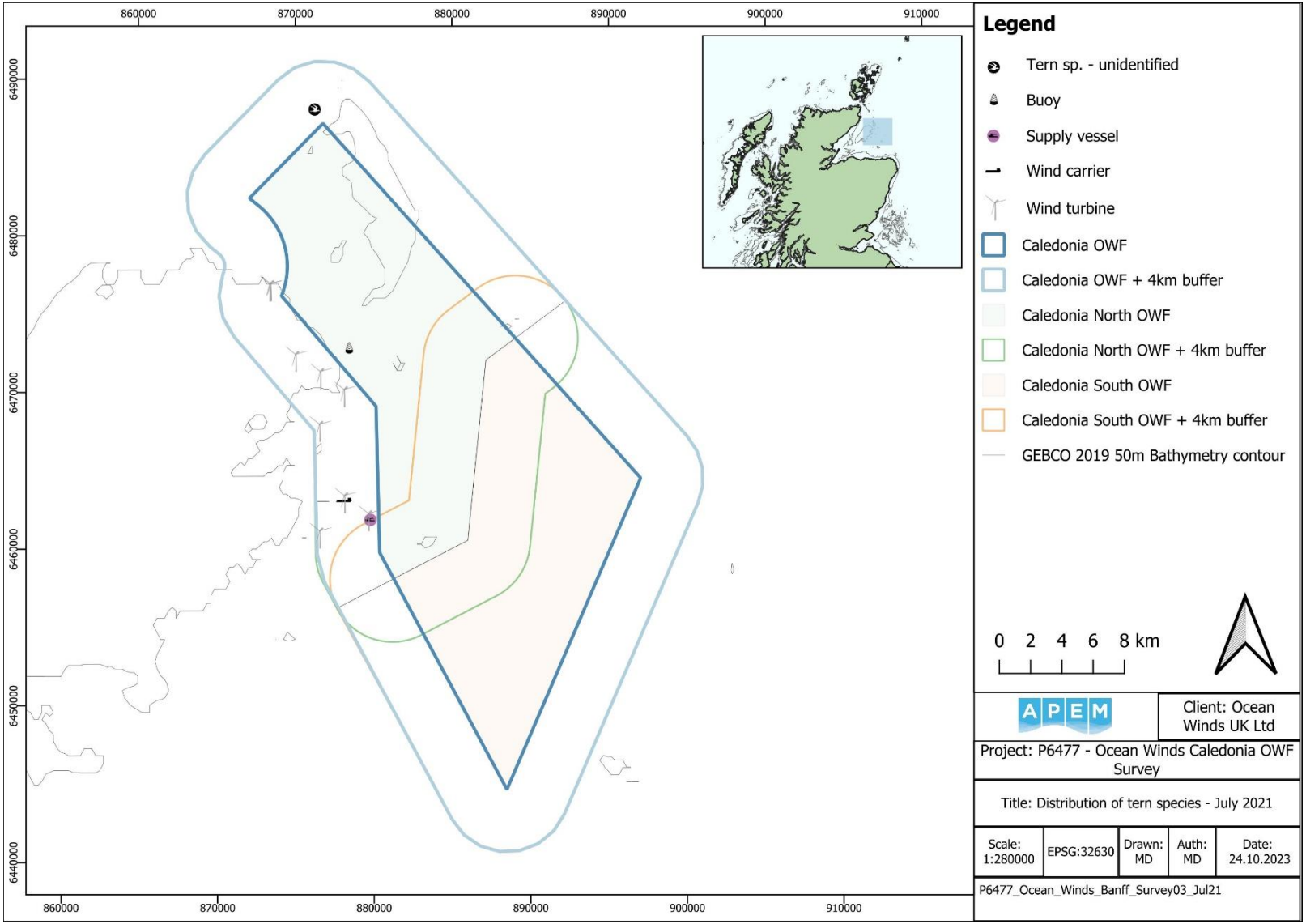



**Figure A4.137 Distribution of tern species recorded in the Survey Area in July 2021**

## Great skua

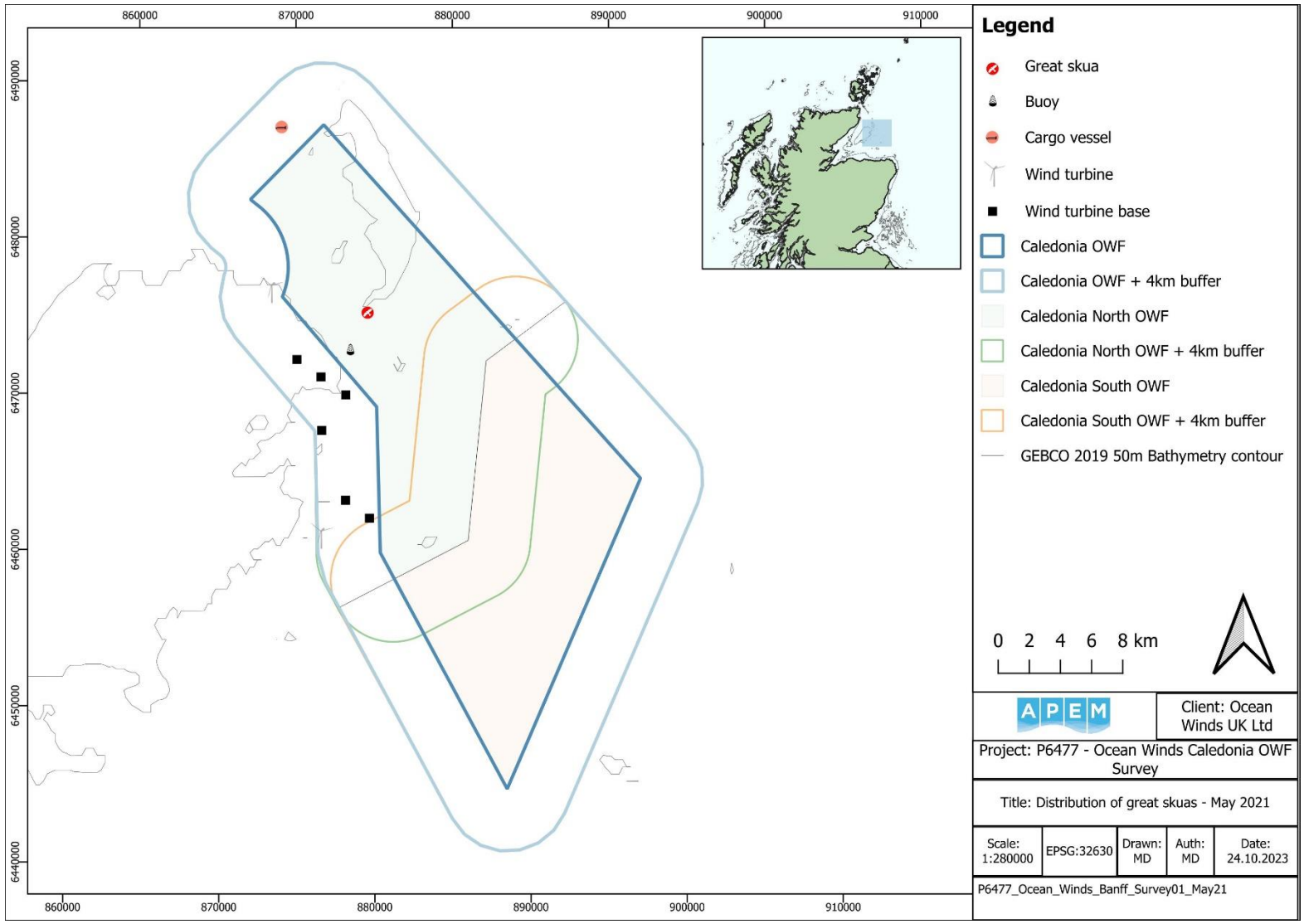



**Figure A4.138 Distribution of great skuas recorded in the Survey Area in May 2021**

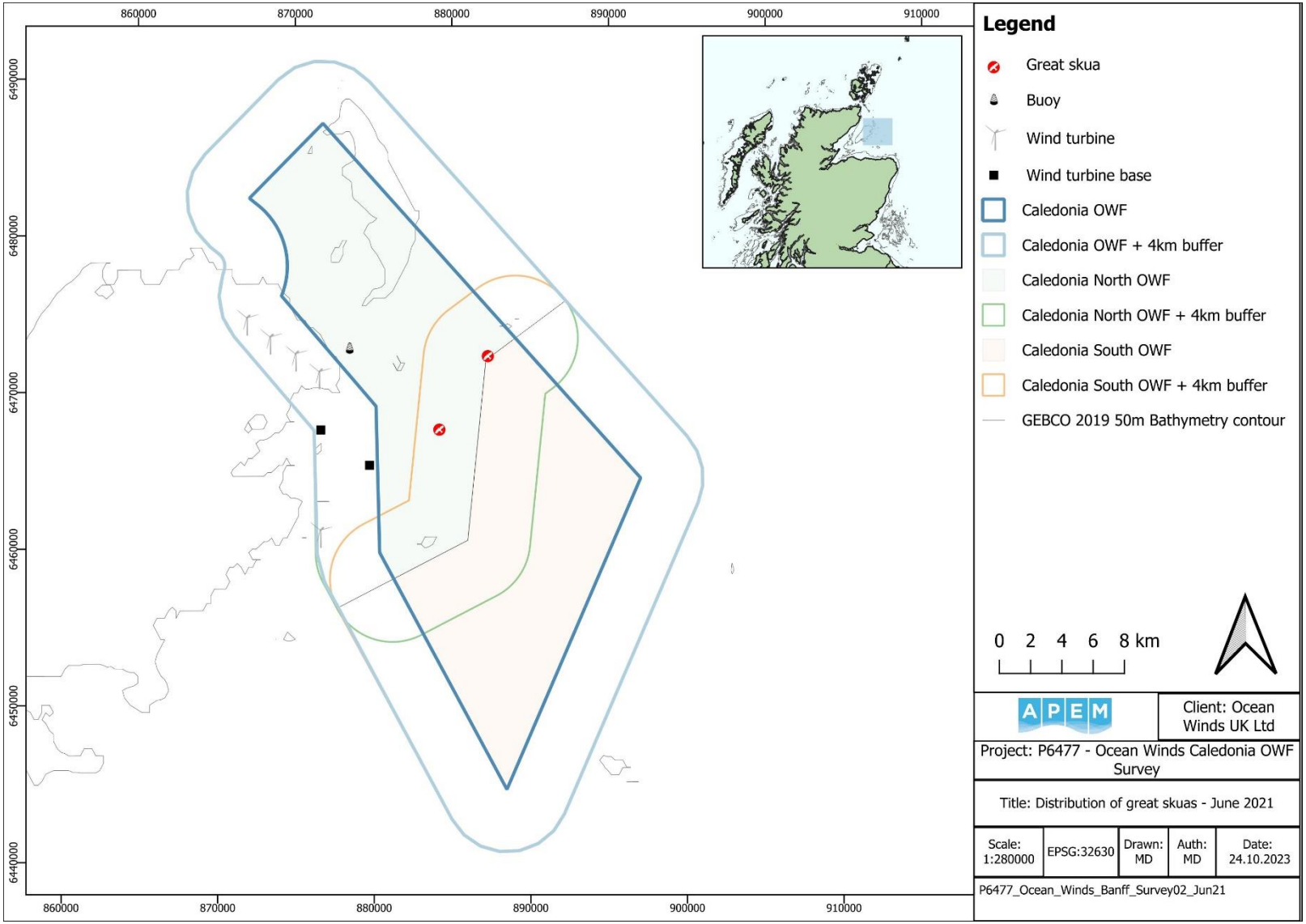



**Figure A4.139 Distribution of great skuas recorded in the Survey Area in June 2021**

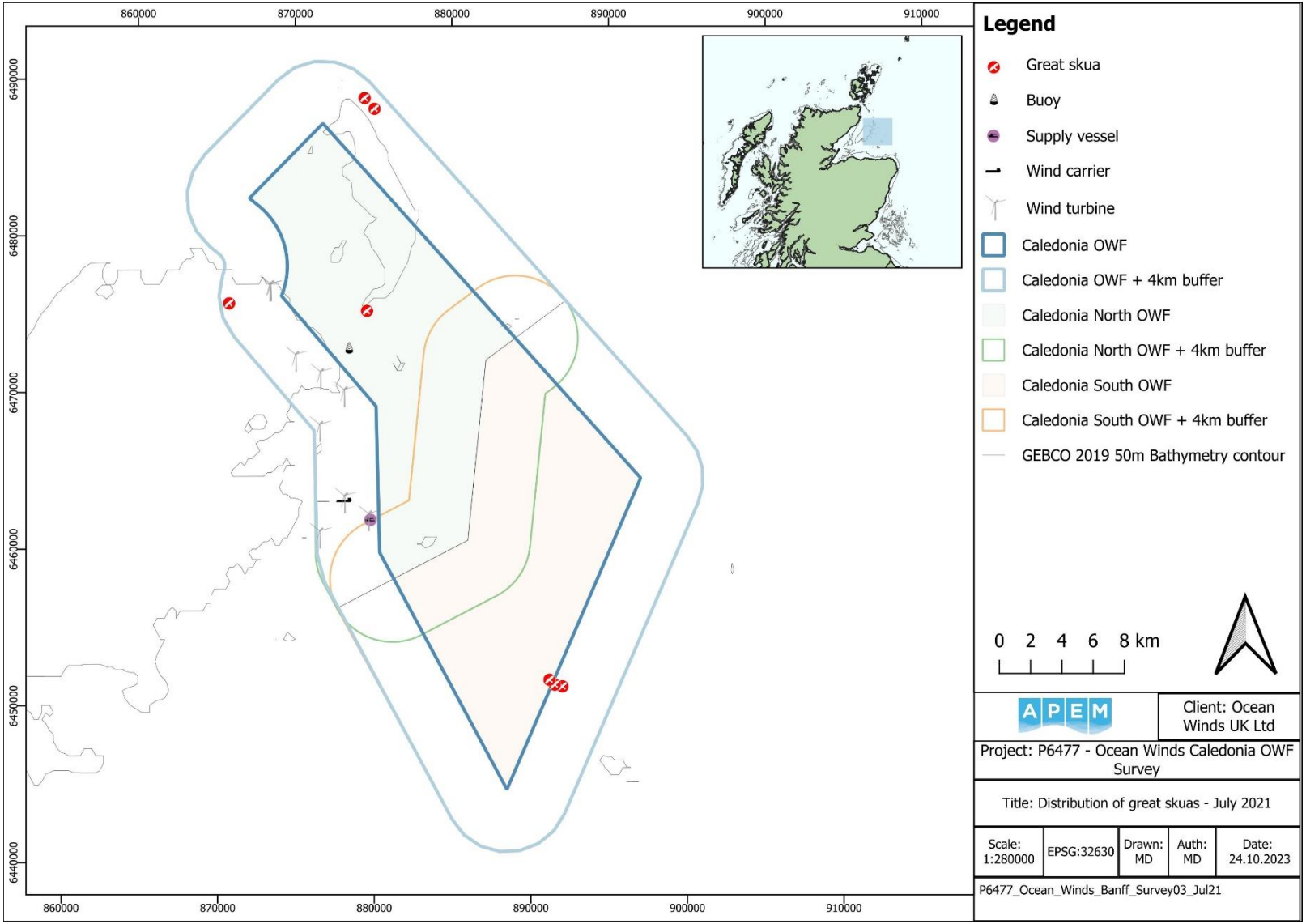



**Figure A4.140 Distribution of great skuas recorded in the Survey Area in July 2021**

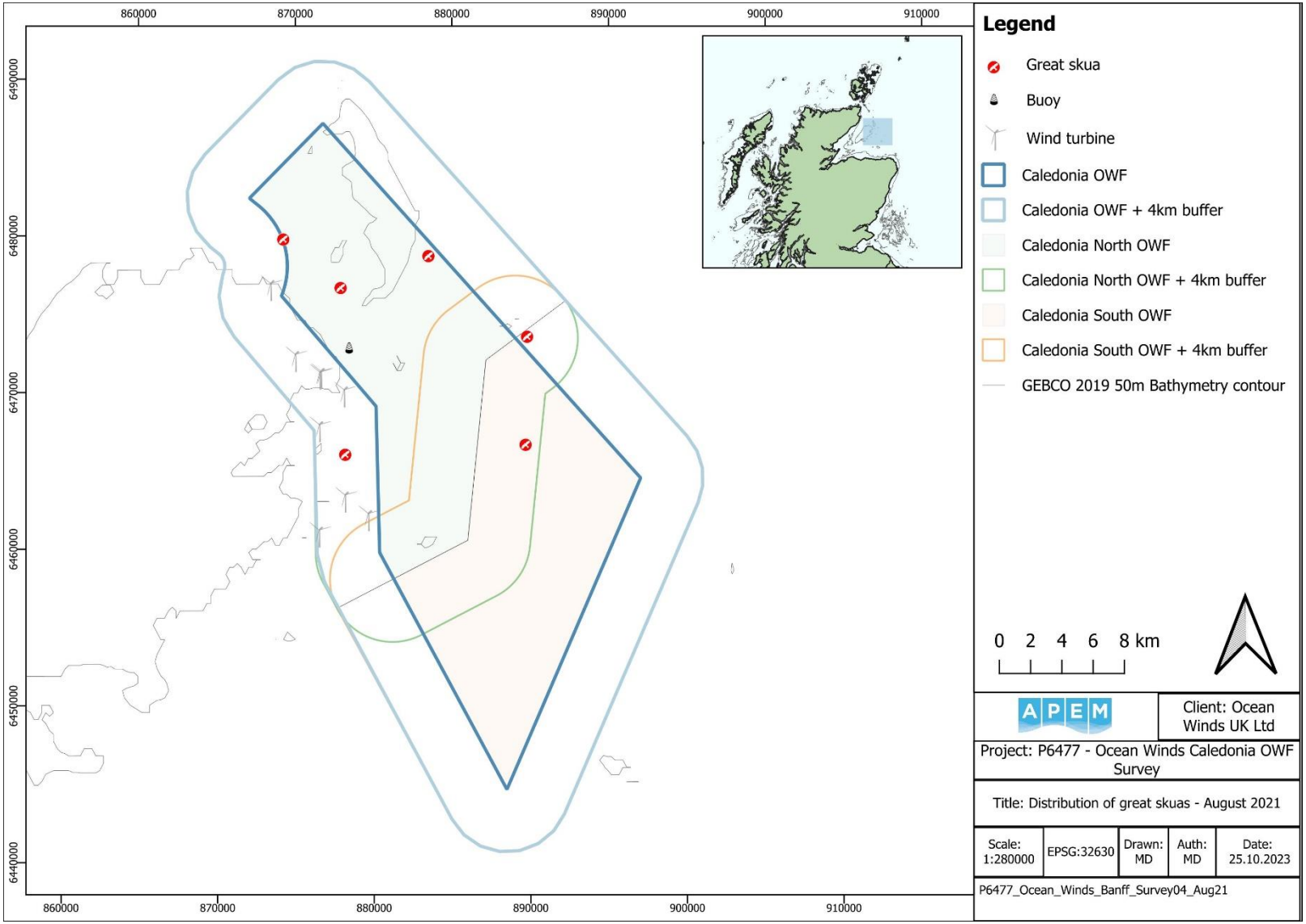



**Figure A4.141 Distribution of great skuas recorded in the Survey Area in August 2021**

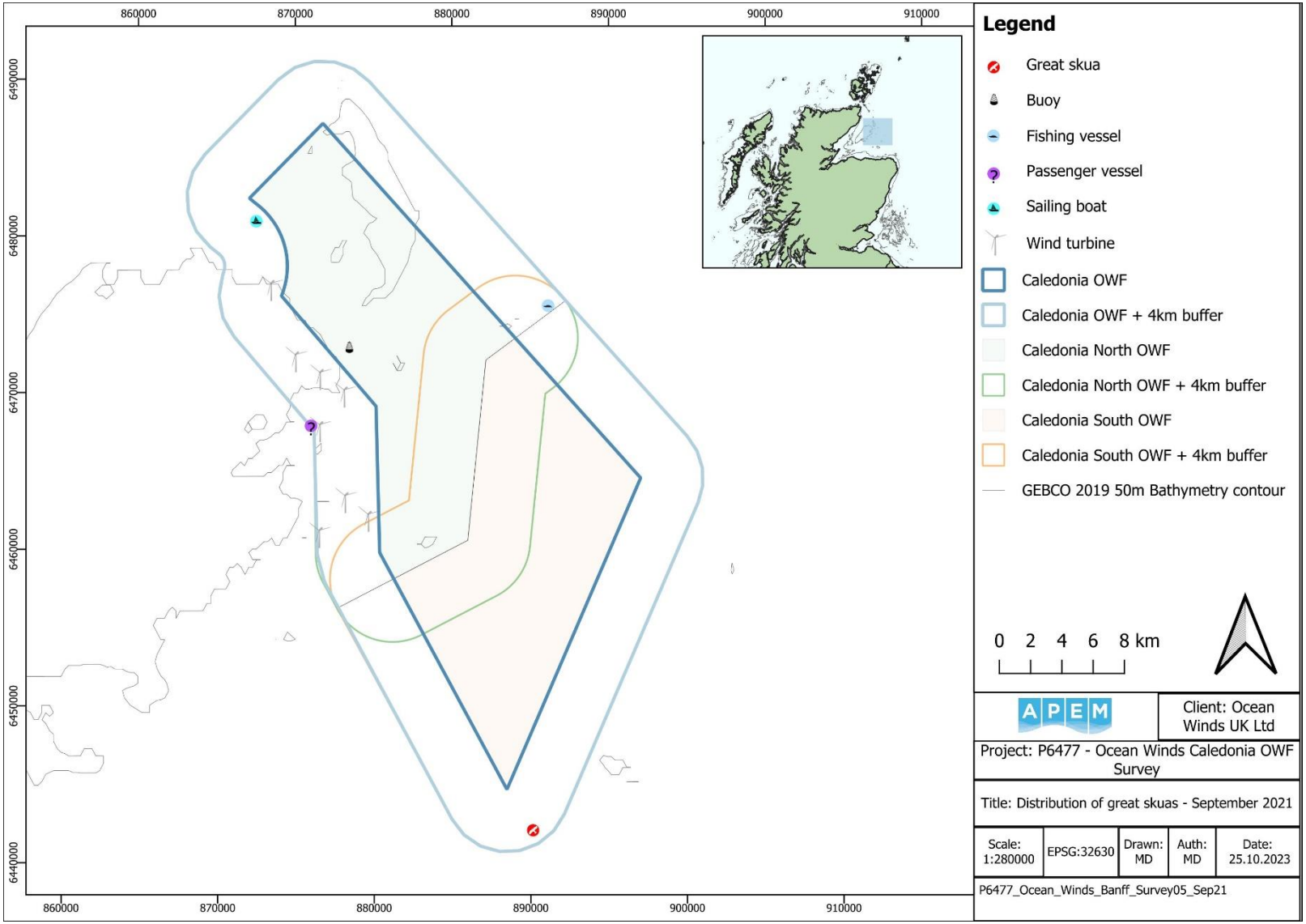



**Figure A4.142 Distribution of great skuas recorded in the Survey Area in September 2021**

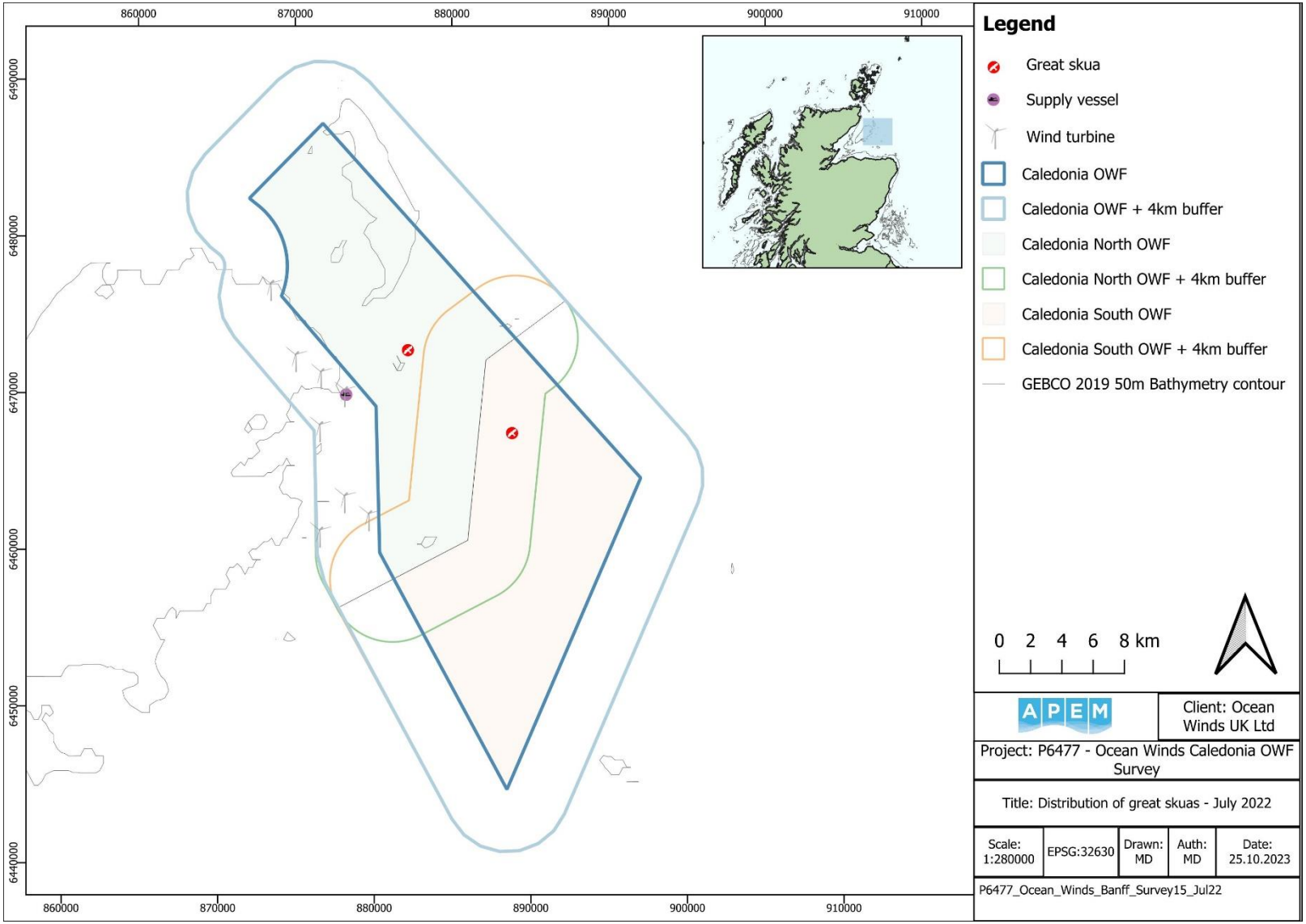



**Figure A4.143 Distribution of great skuas recorded in the Survey Area in July 2022**

## Arctic skua

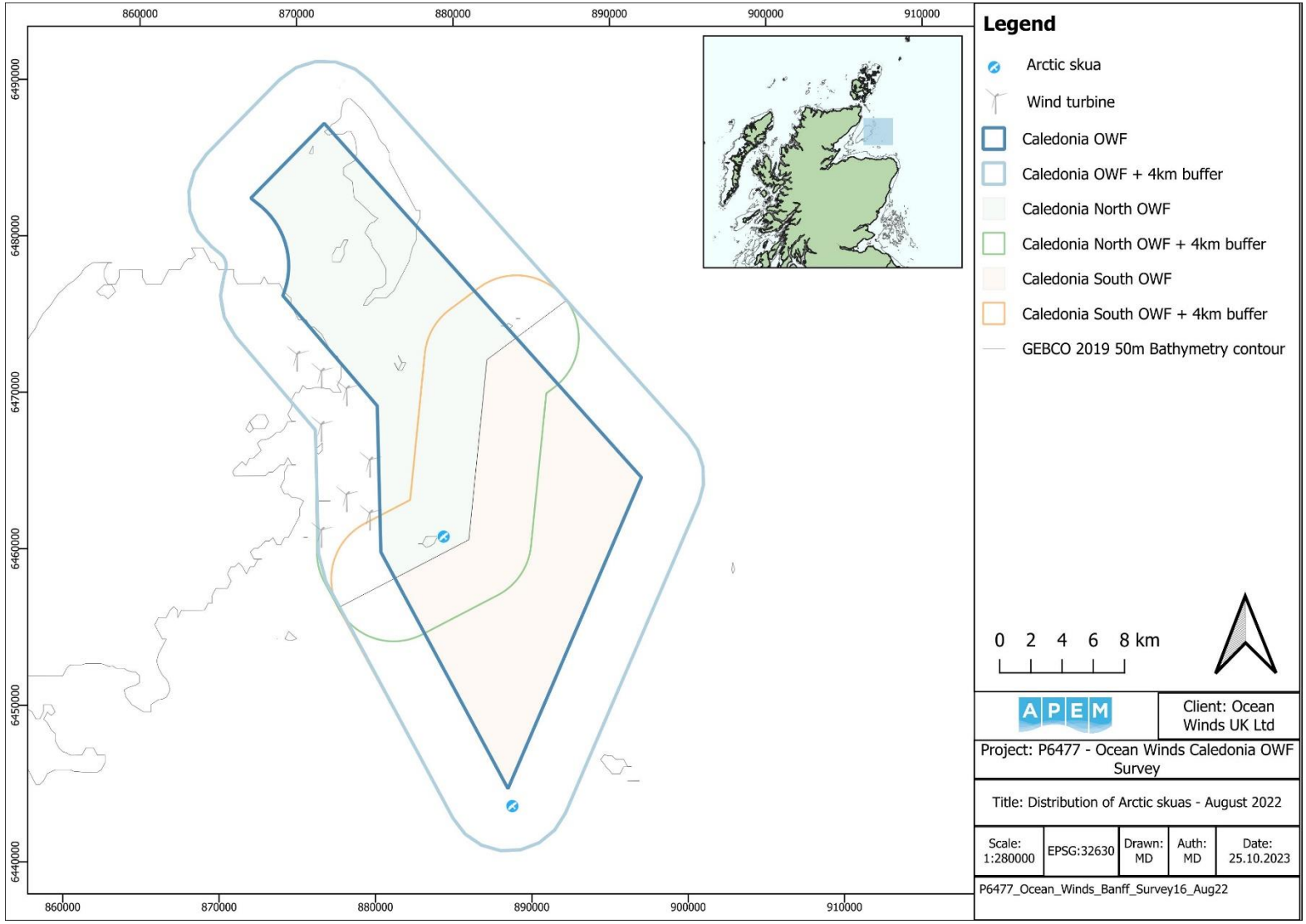



**Figure A4.144 Distribution of Arctic skuas recorded in the Survey Area in August 2022**

## Guillemot

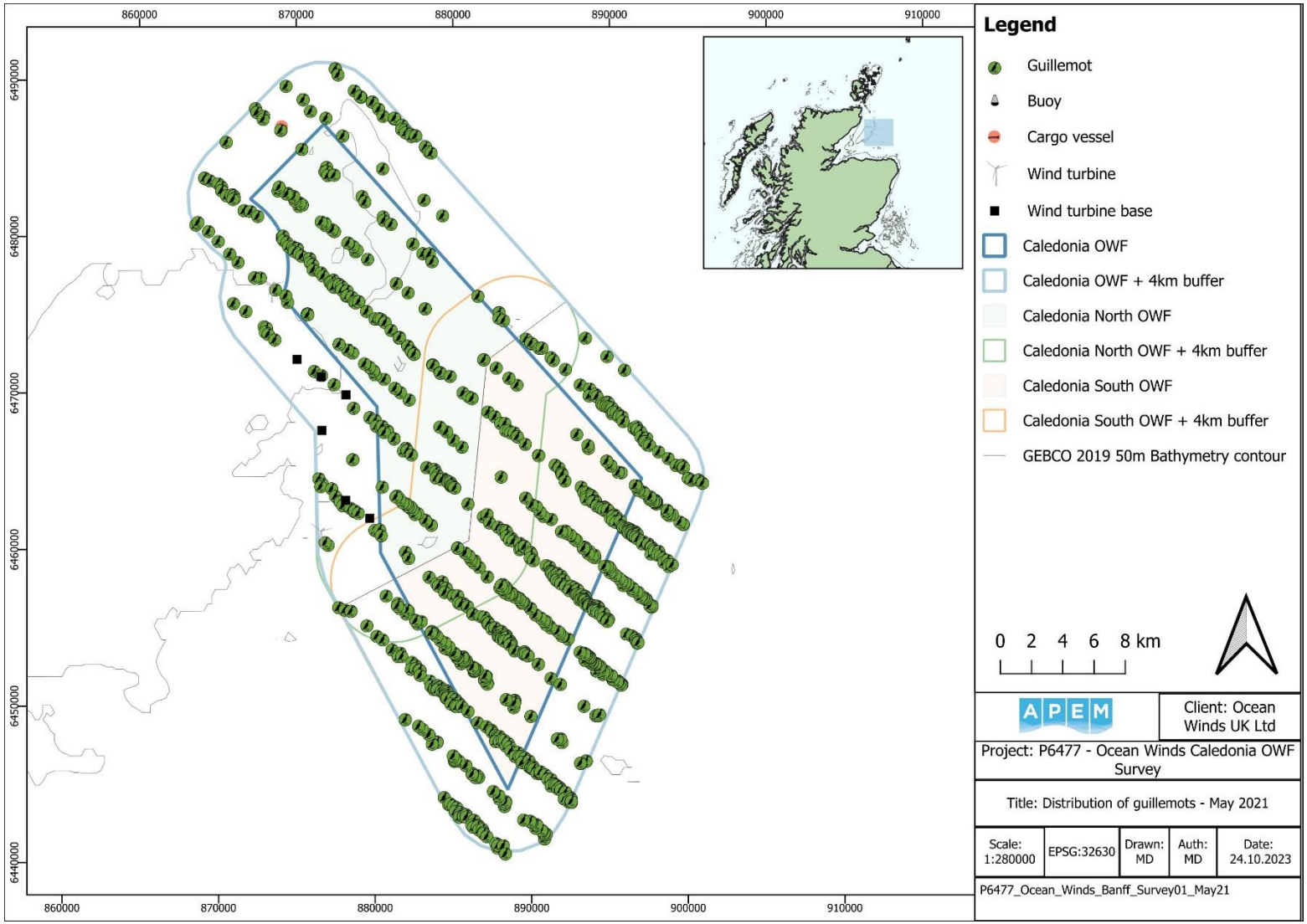



**Figure A4.145 Distribution of guillemots recorded in the Survey Area in May 2021**

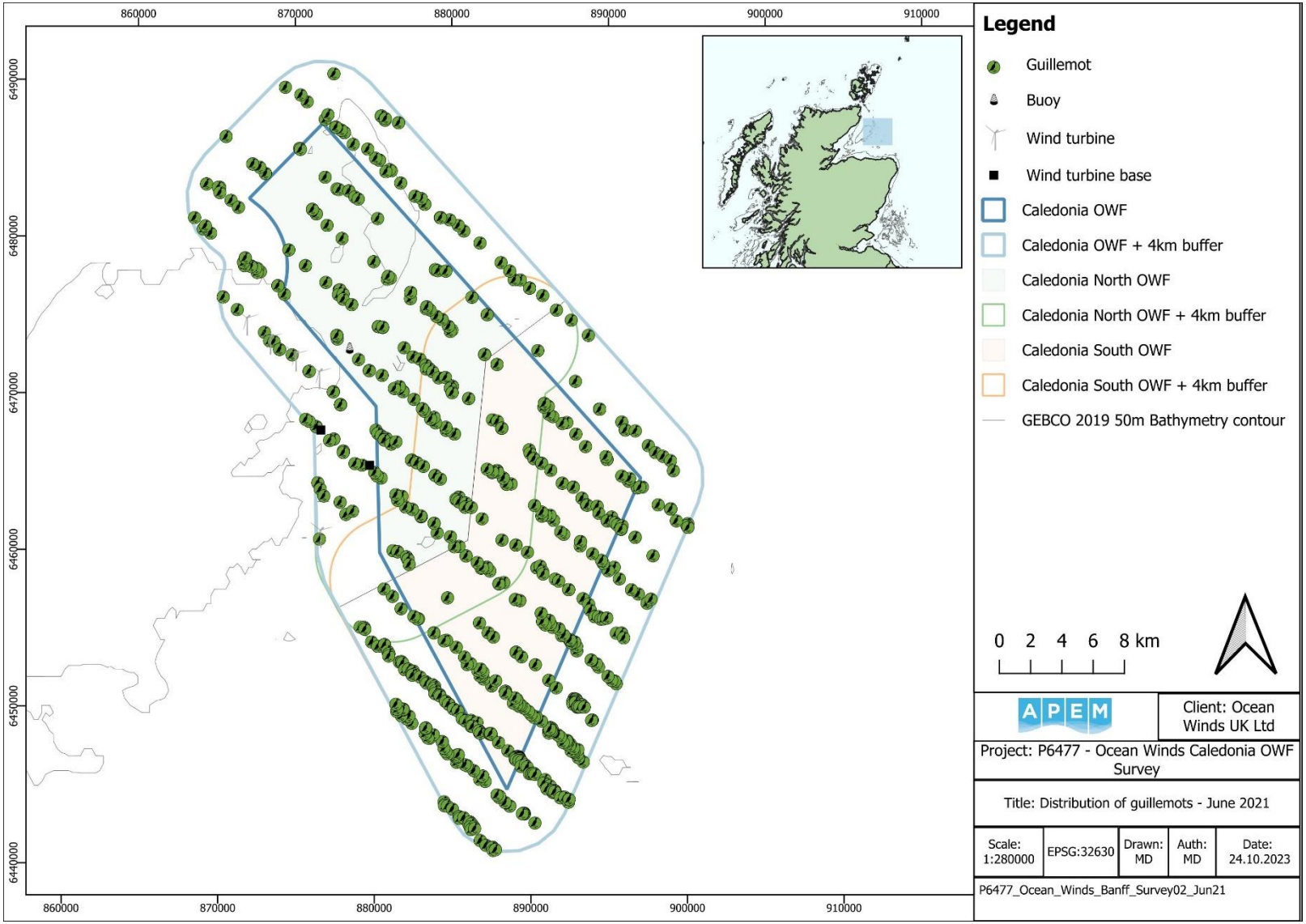



**Figure A4.146 Distribution of guillemots recorded in the Survey Area in June 2021**

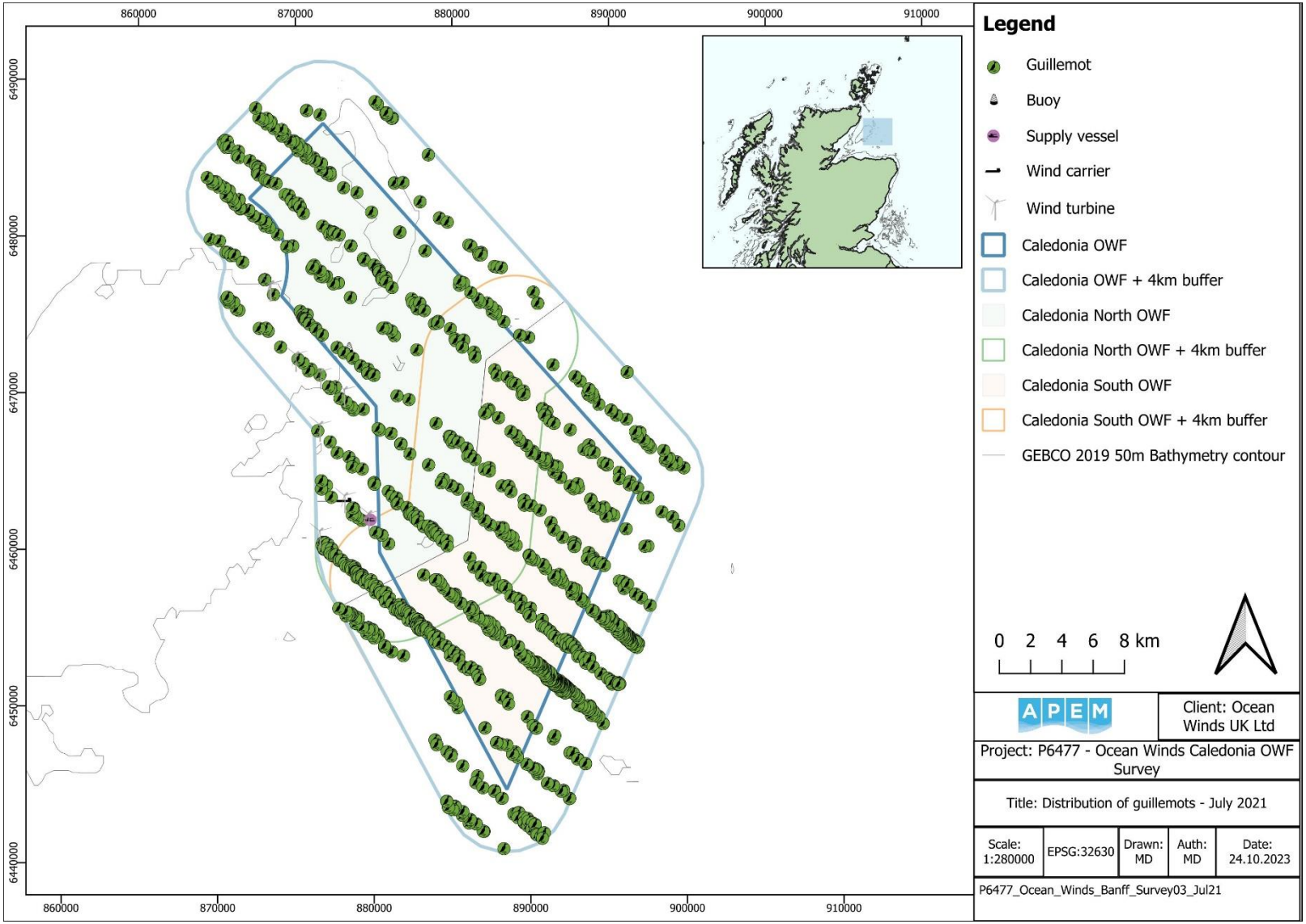



**Figure A4.147 Distribution of guillemots recorded in the Survey Area in July 2021**

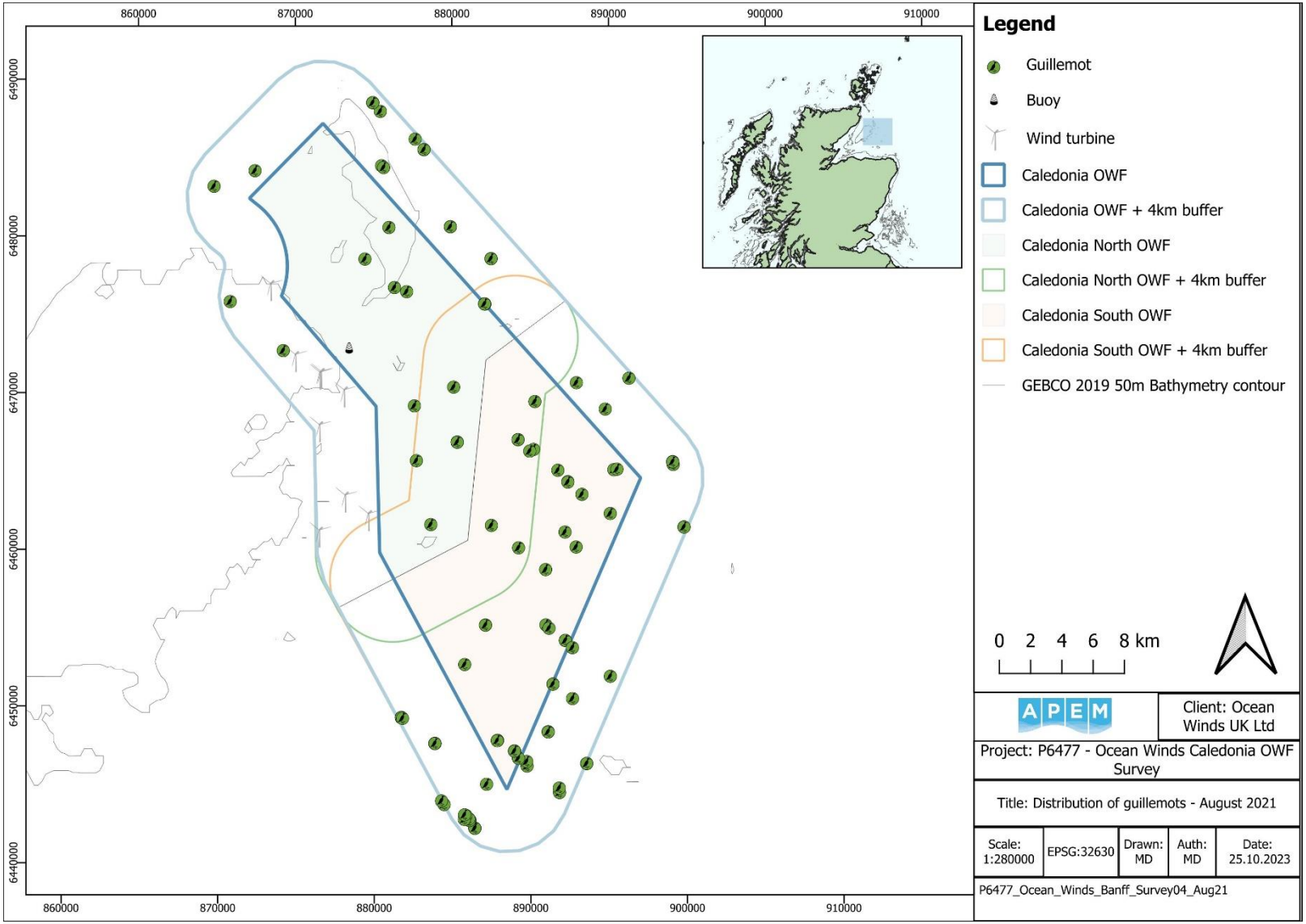



**Figure A4.148 Distribution of guillemots recorded in the Survey Area in August 2021**

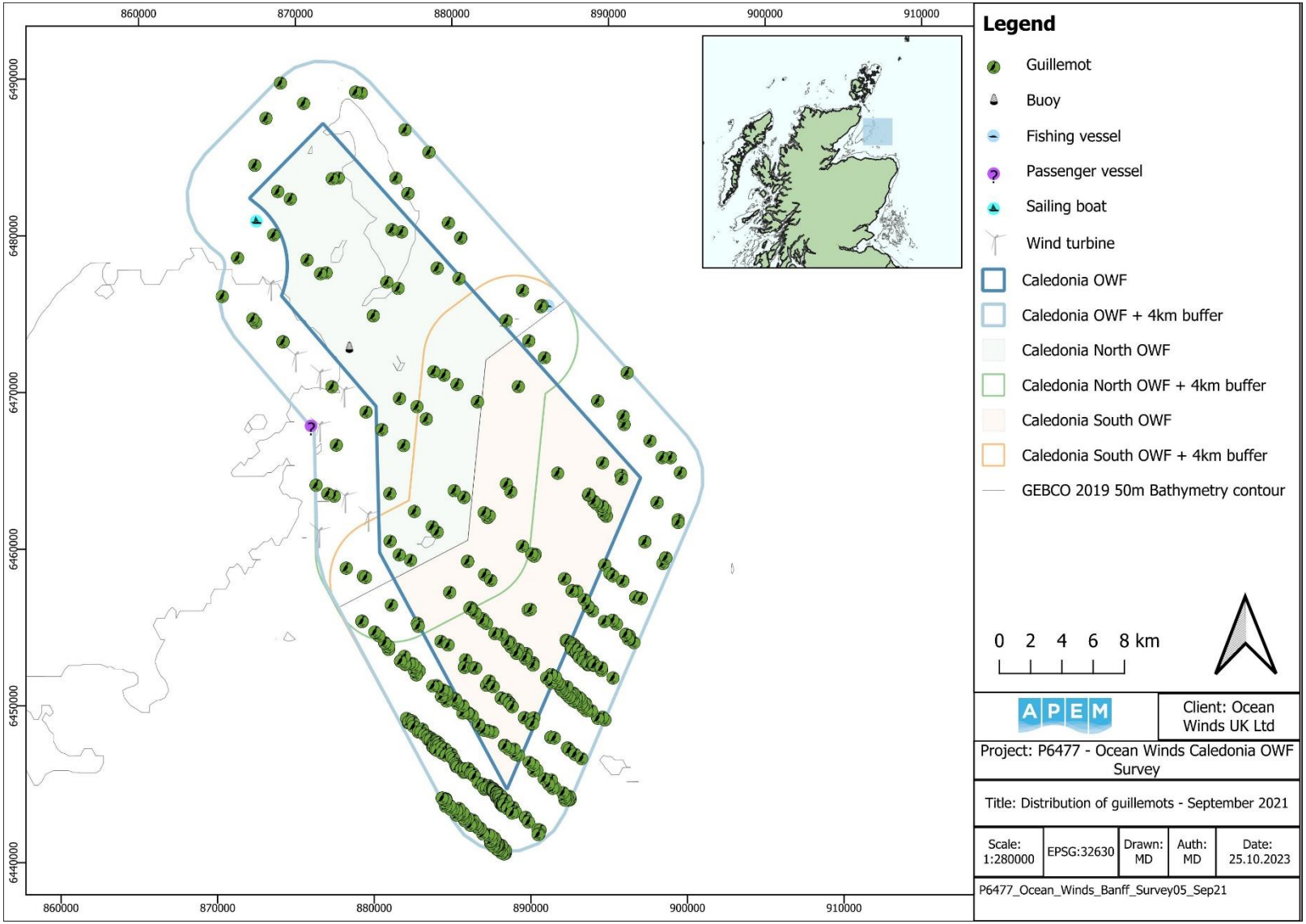



**Figure A4.149 Distribution of guillemots recorded in the Survey Area in September 2021**

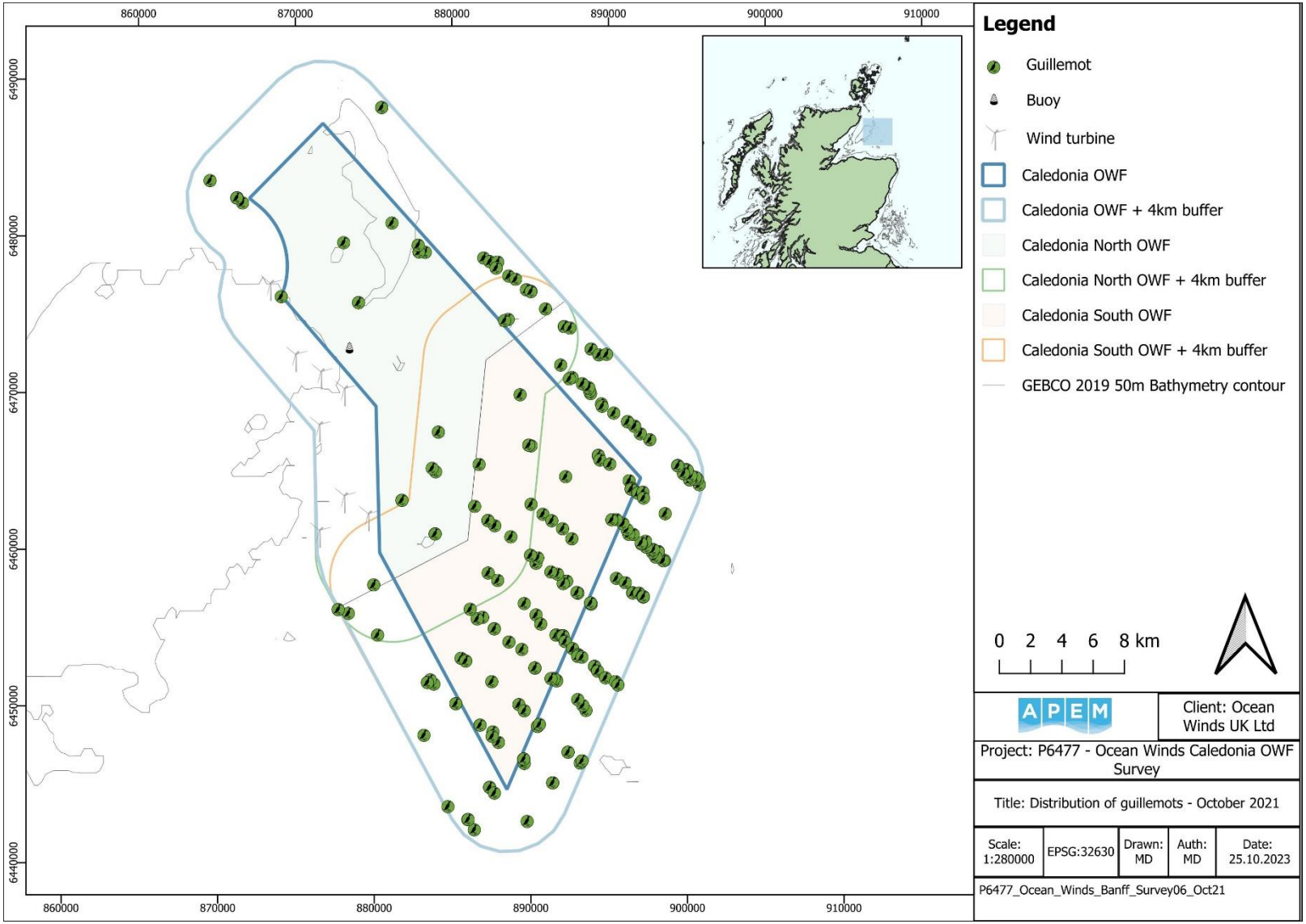



**Figure A4.150 Distribution of guillemots recorded in the Survey Area in October 2021**

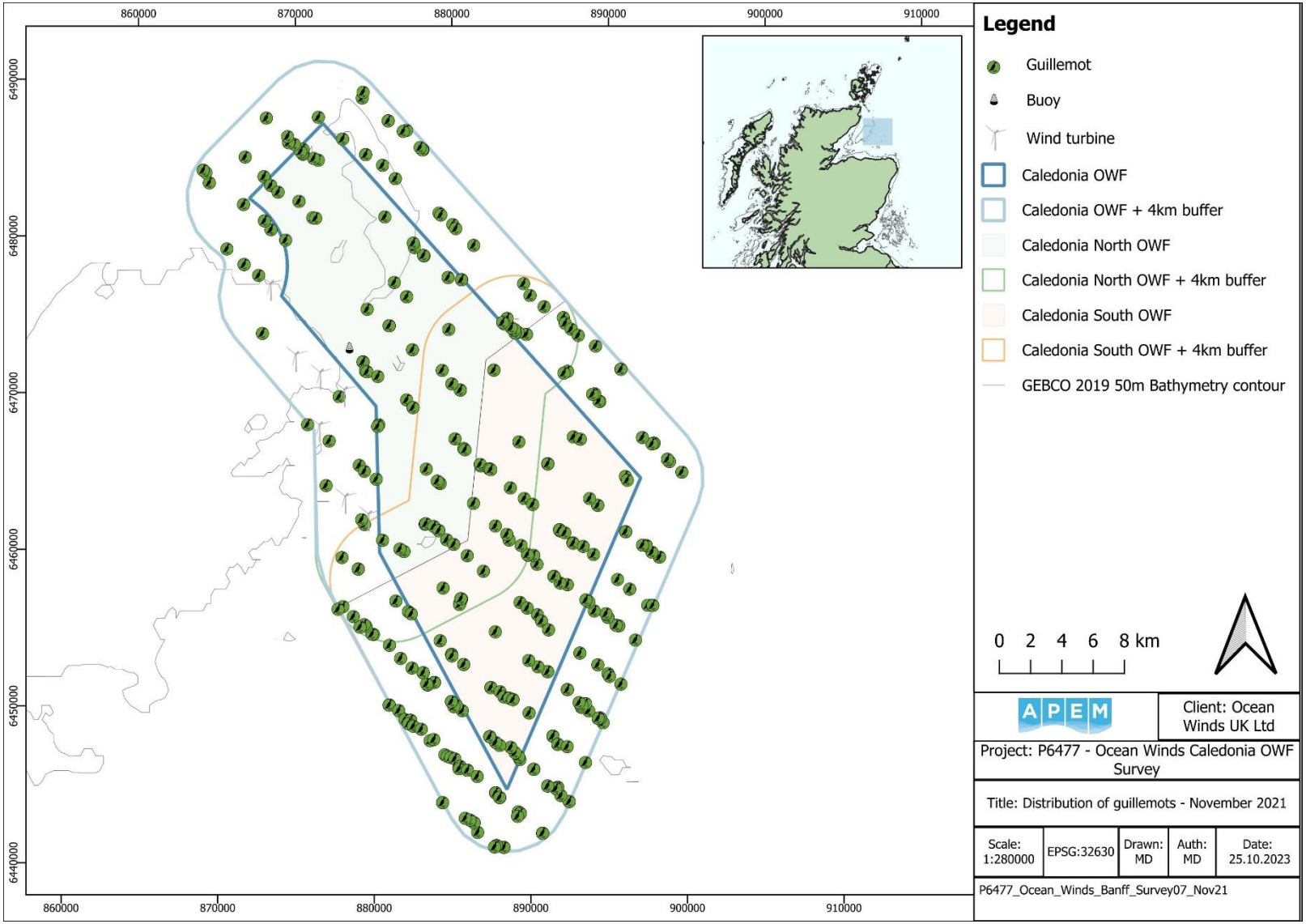



**Figure A4.151 Distribution of guillemots recorded in the Survey Area in November 2021**

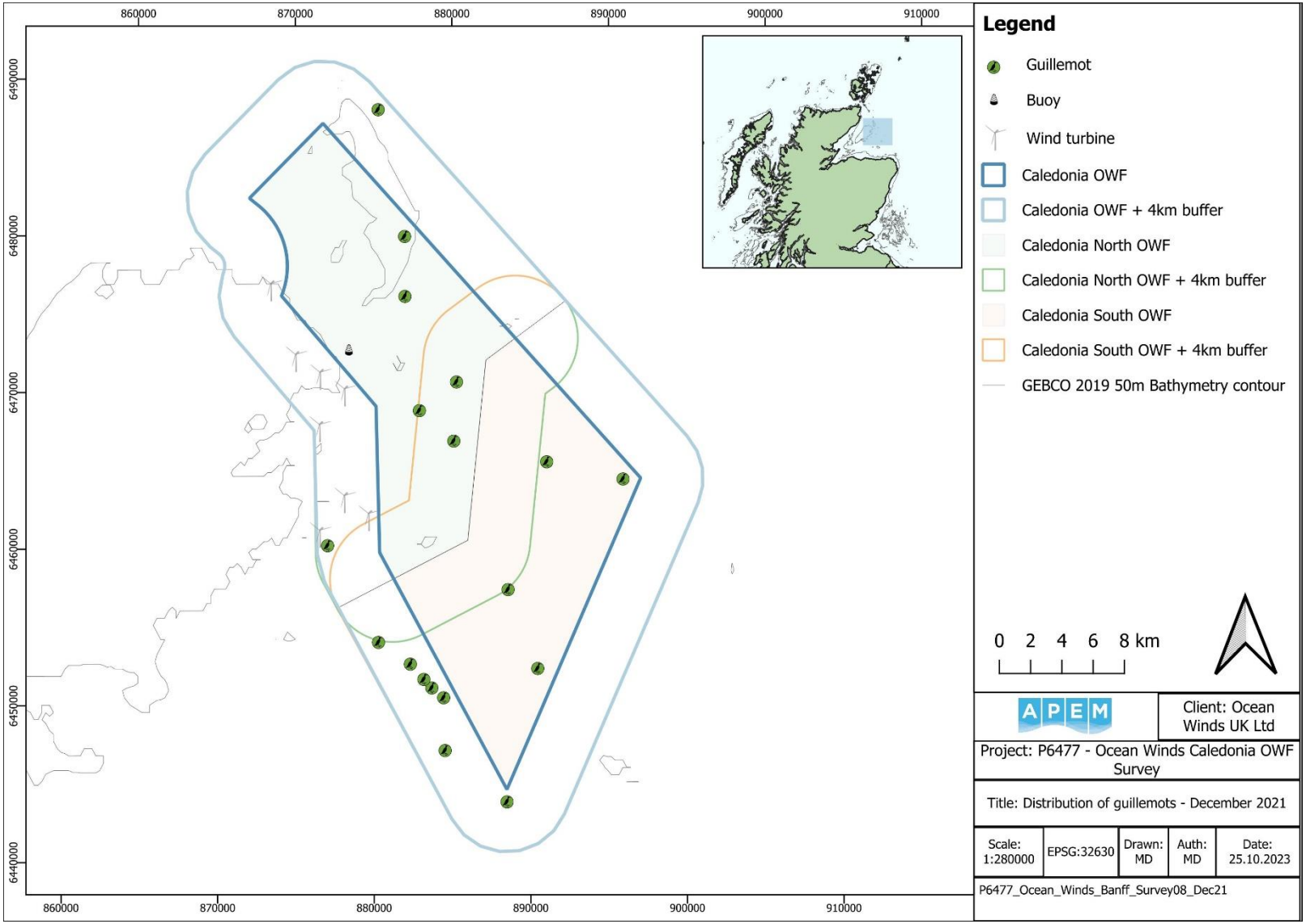



**Figure A4.152 Distribution of guillemots recorded in the Survey Area in December 2021**

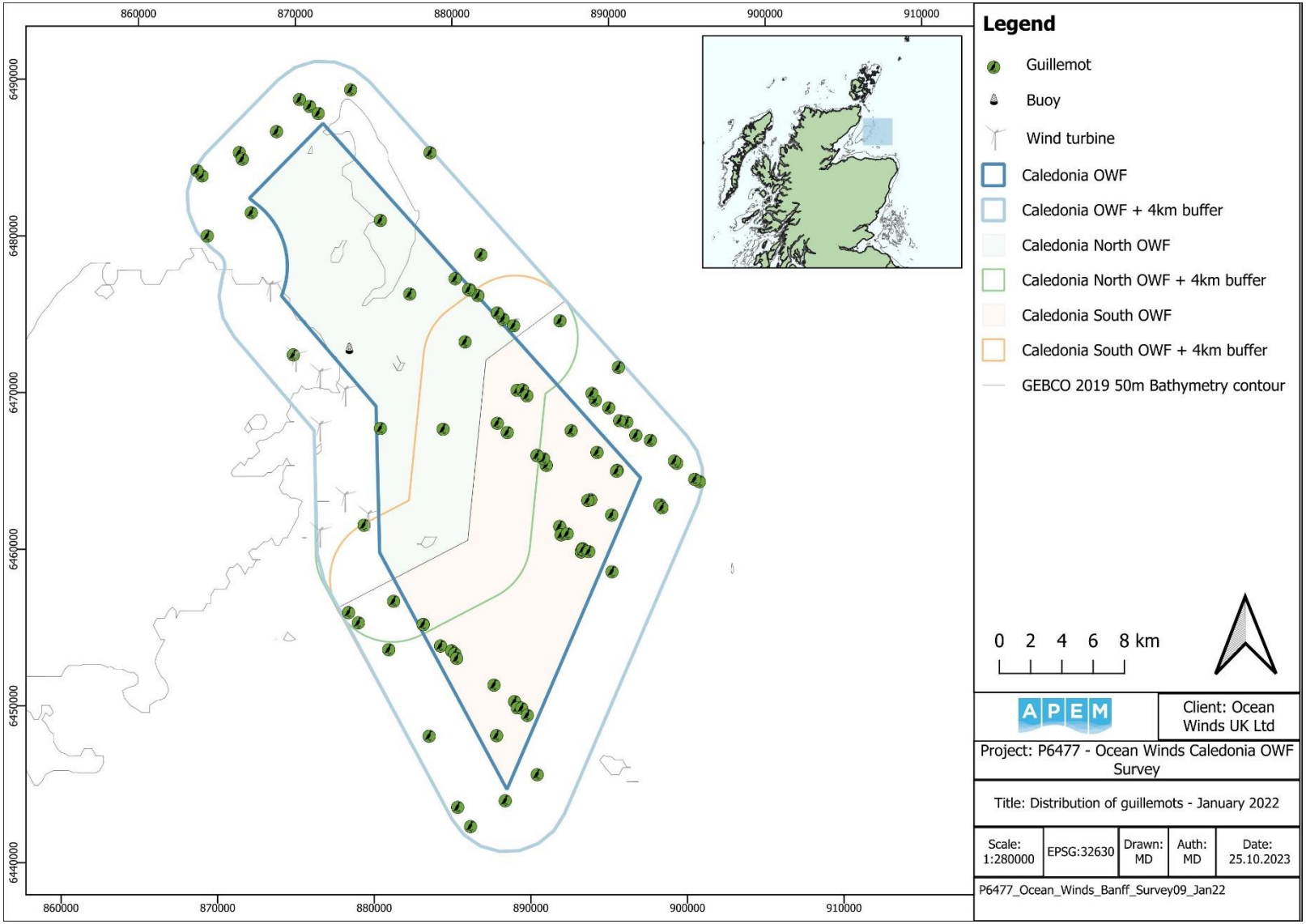



**Figure A4.153 Distribution of guillemots recorded in the Survey Area in January 2022**

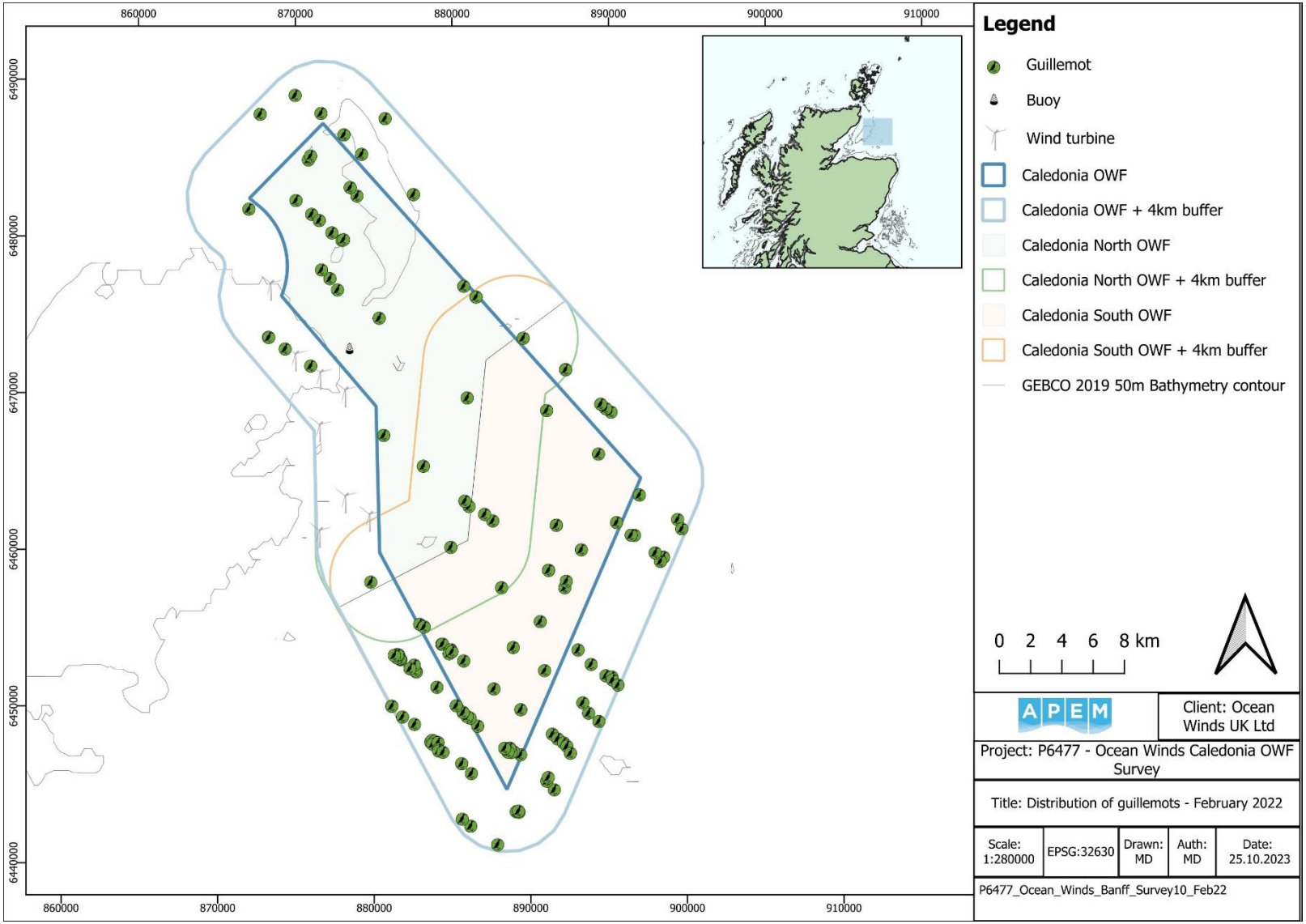



**Figure A4.154 Distribution of guillemots recorded in the Survey Area in February 2022**

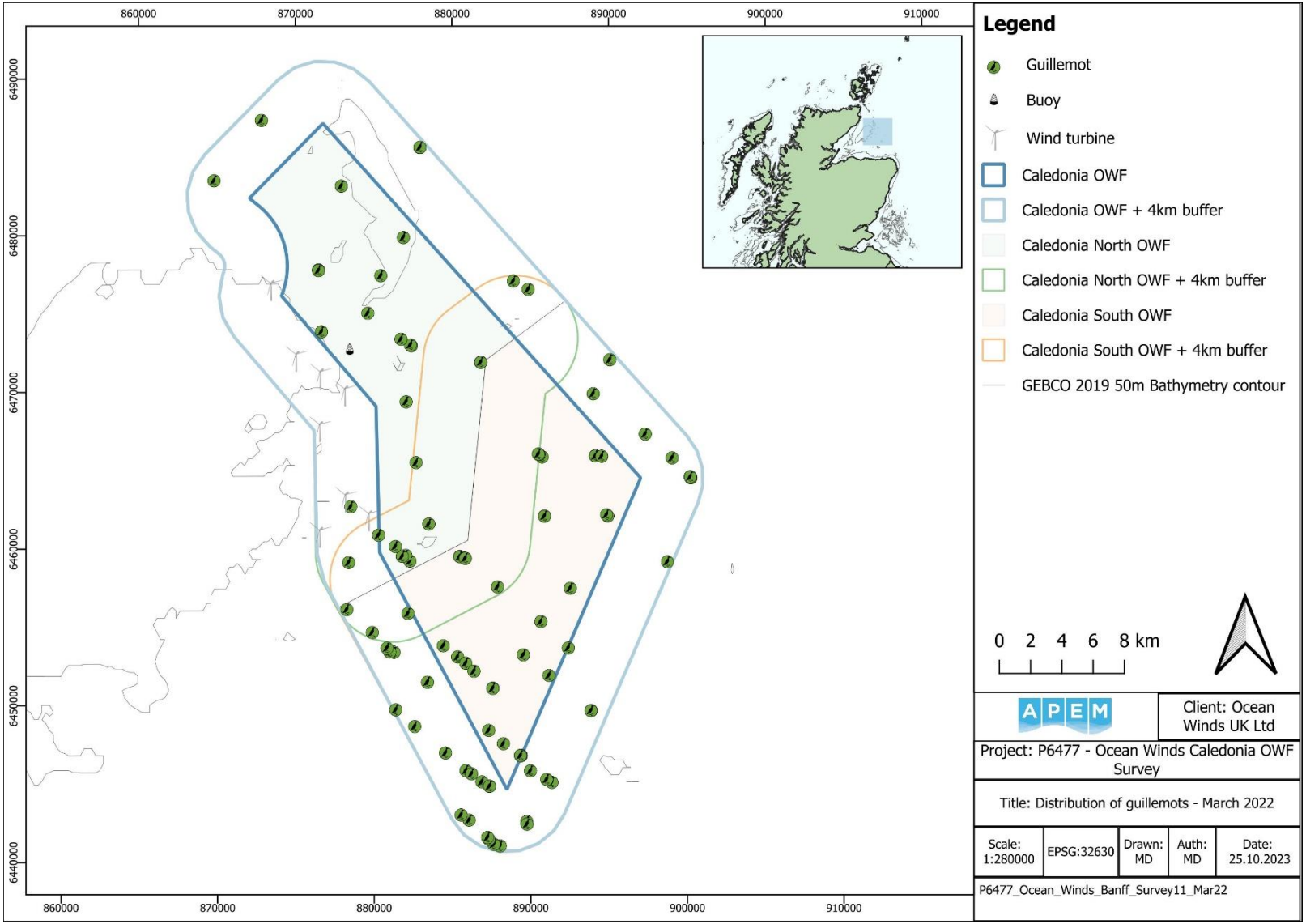



**Figure A4.155 Distribution of guillemots recorded in the Survey Area in March 2022**

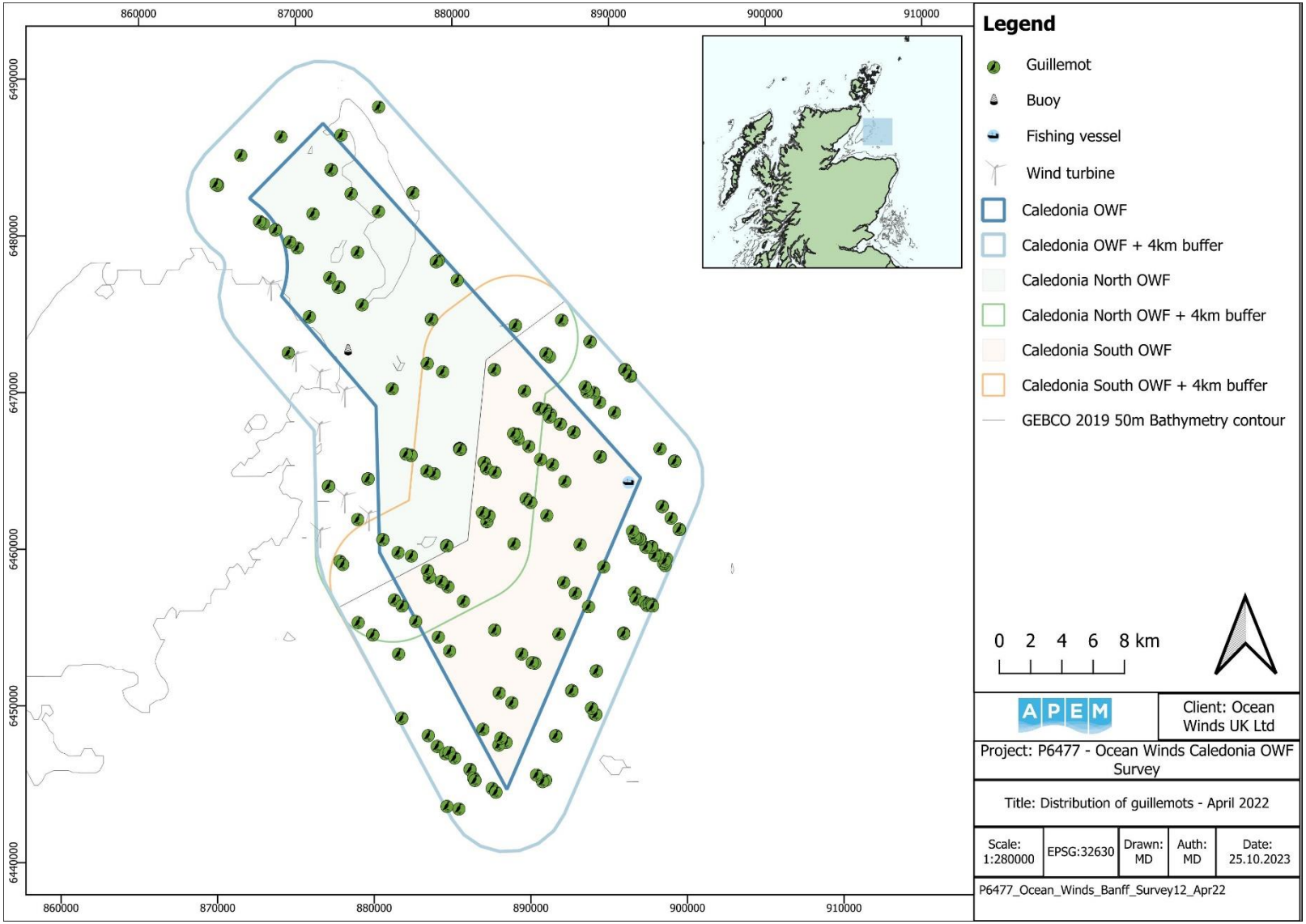



**Figure A4.156 Distribution of guillemots recorded in the Survey Area in April 2022**

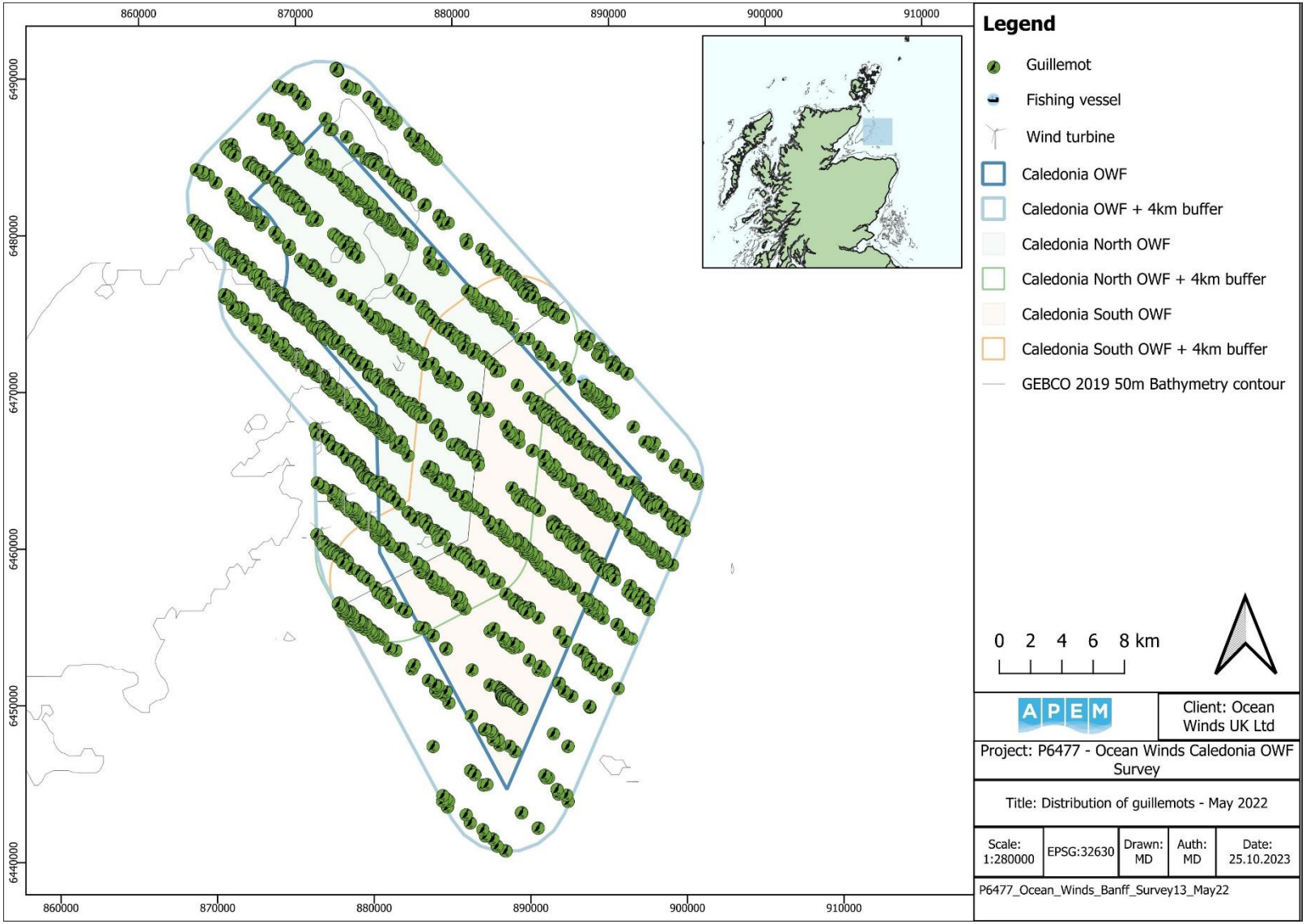



**Figure A4.157 Distribution of guillemots recorded in the Survey Area in May 2022**

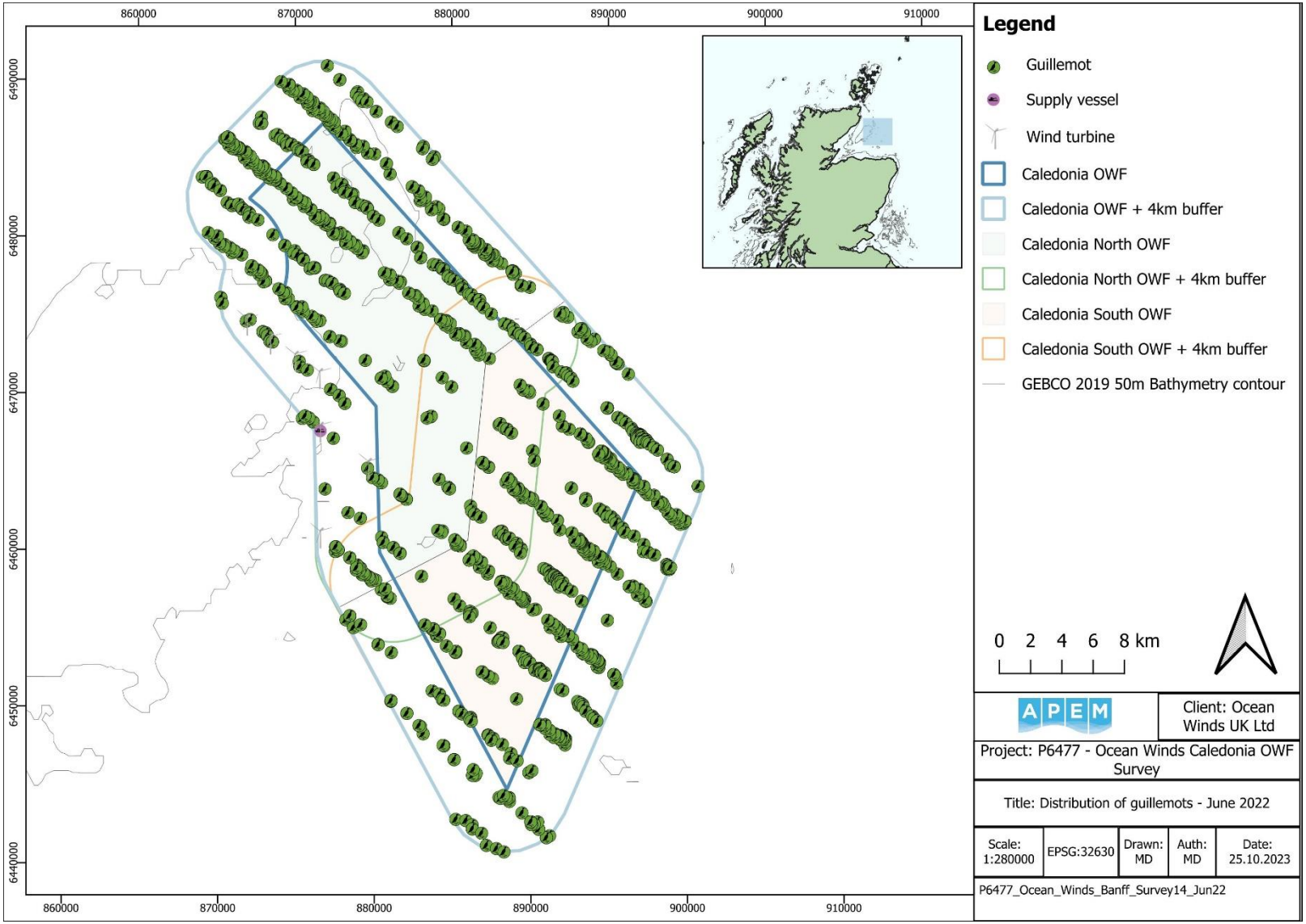



**Figure A4.158 Distribution of guillemots recorded in the Survey Area in June 2022**

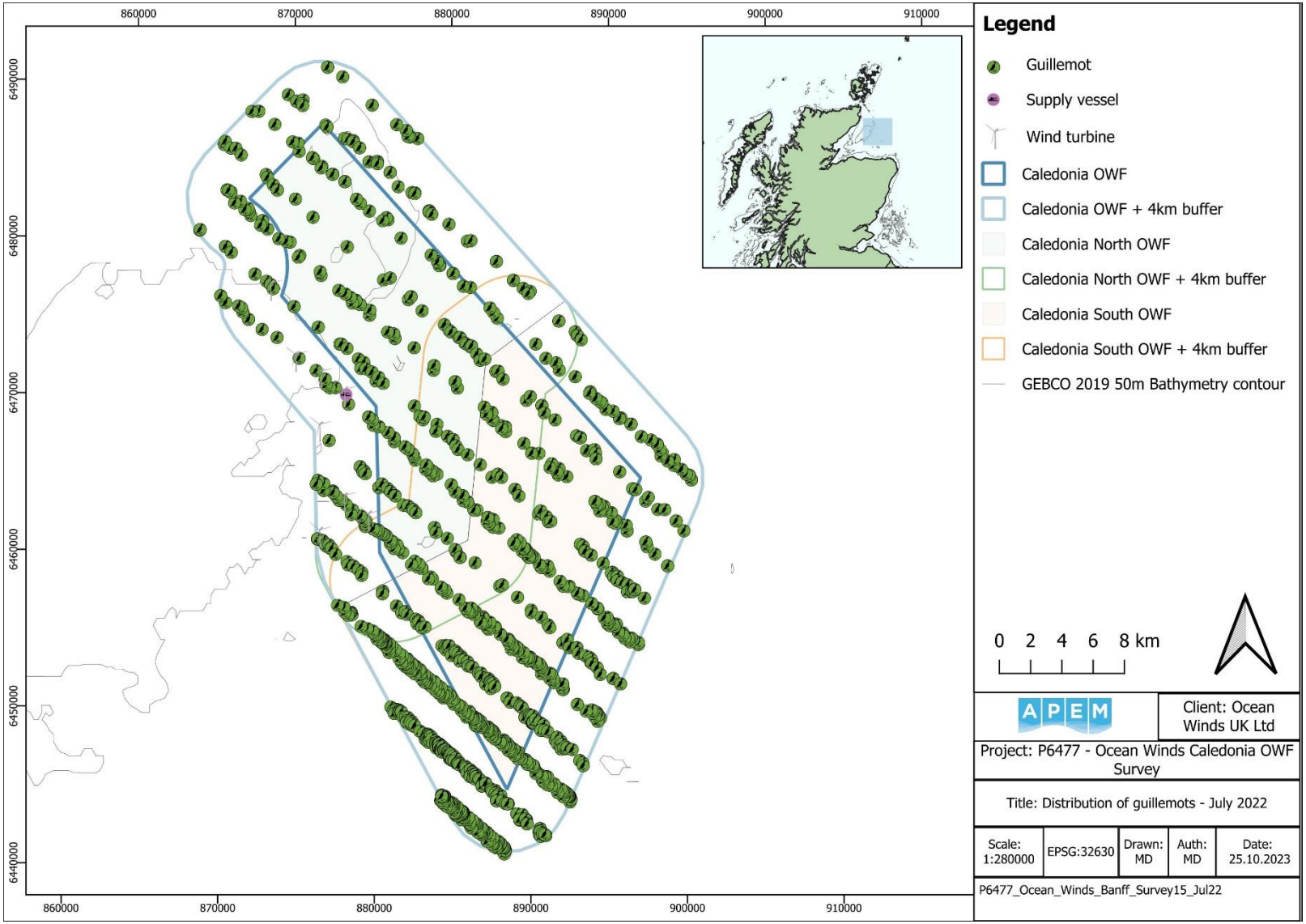



**Figure A4.159 Distribution of guillemots recorded in the Survey Area in July 2022**

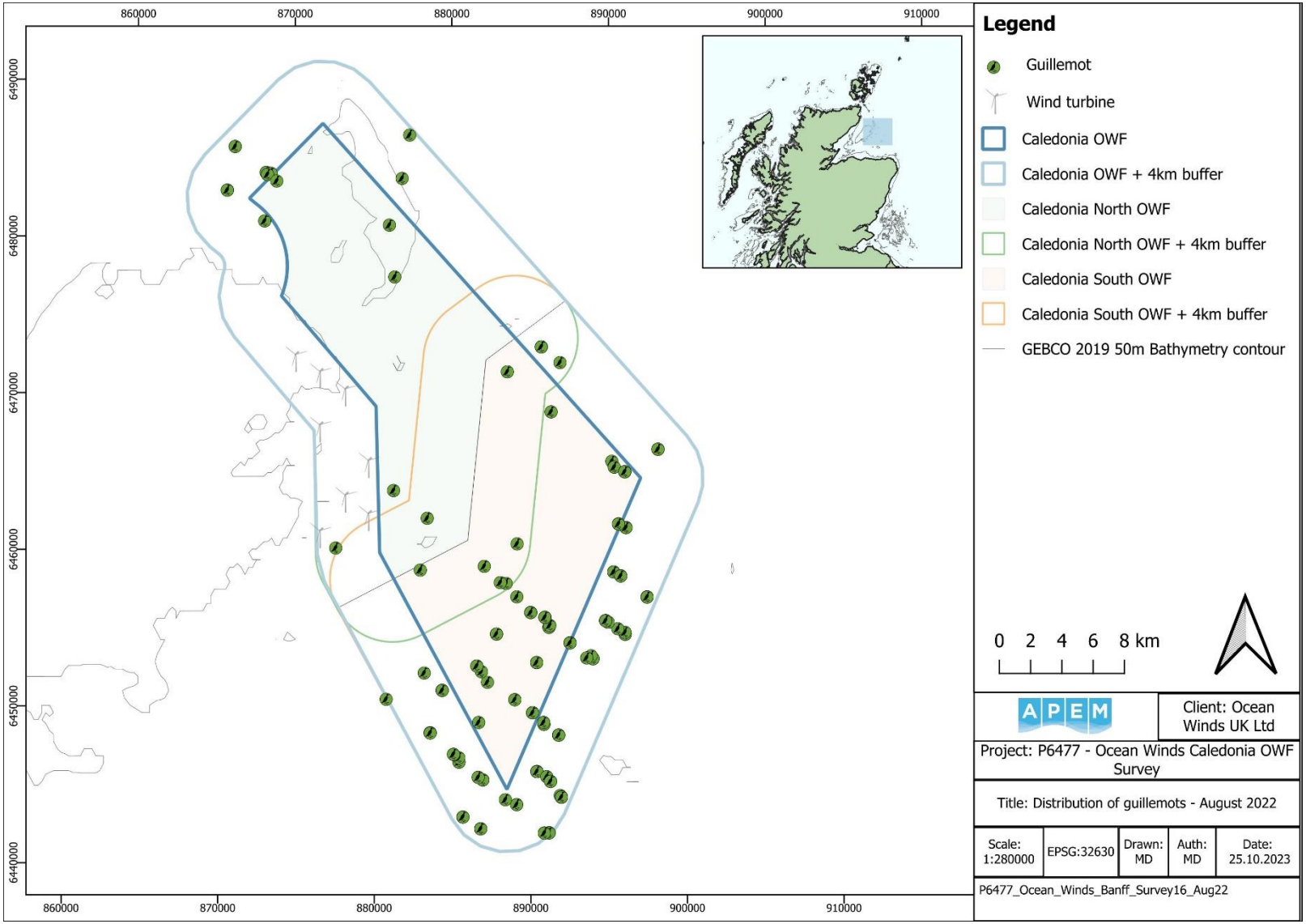



**Figure A4.160 Distribution of guillemots recorded in the Survey Area in August 2022**

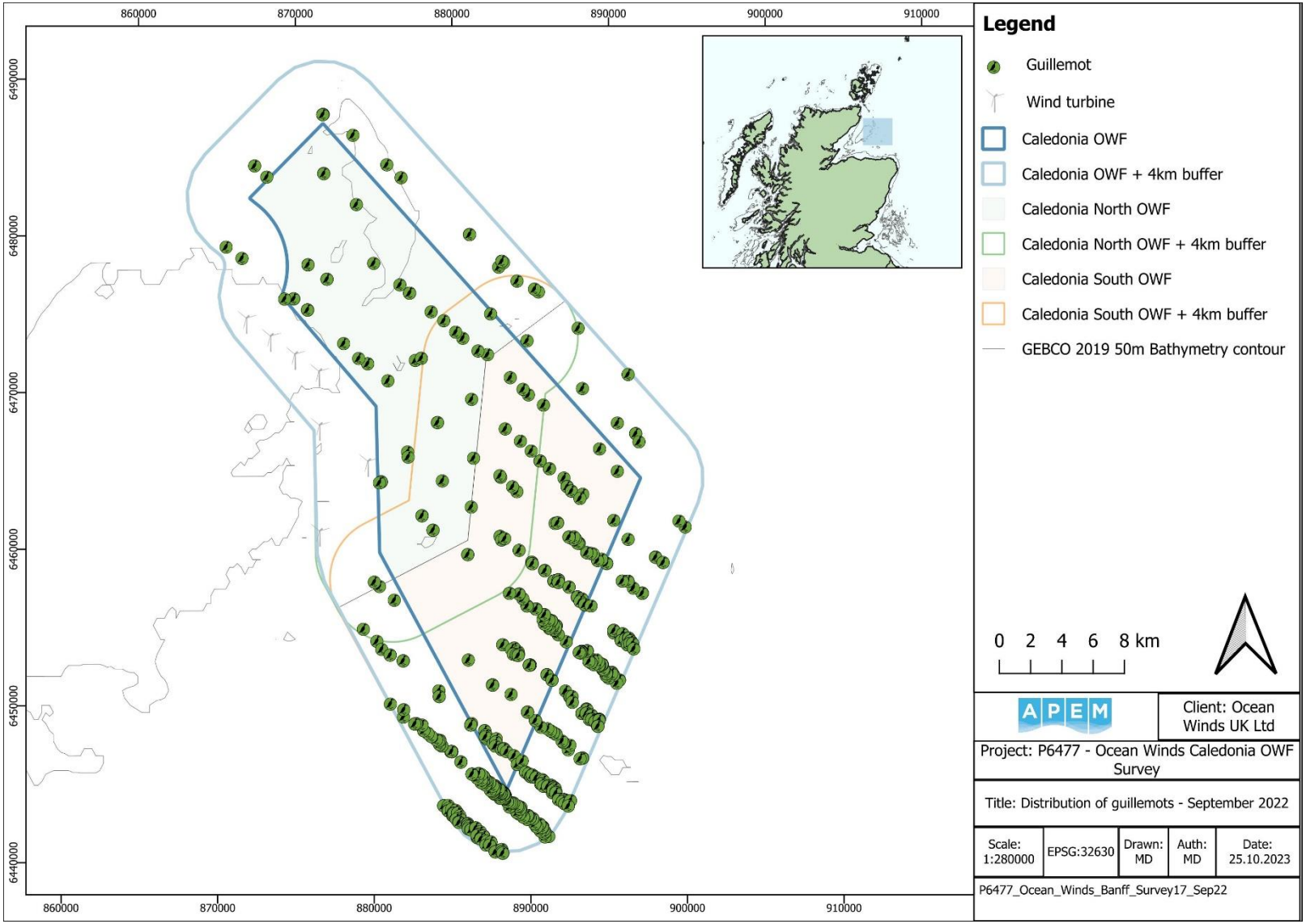



**Figure A4.161 Distribution of guillemots recorded in the Survey Area in September 2022**

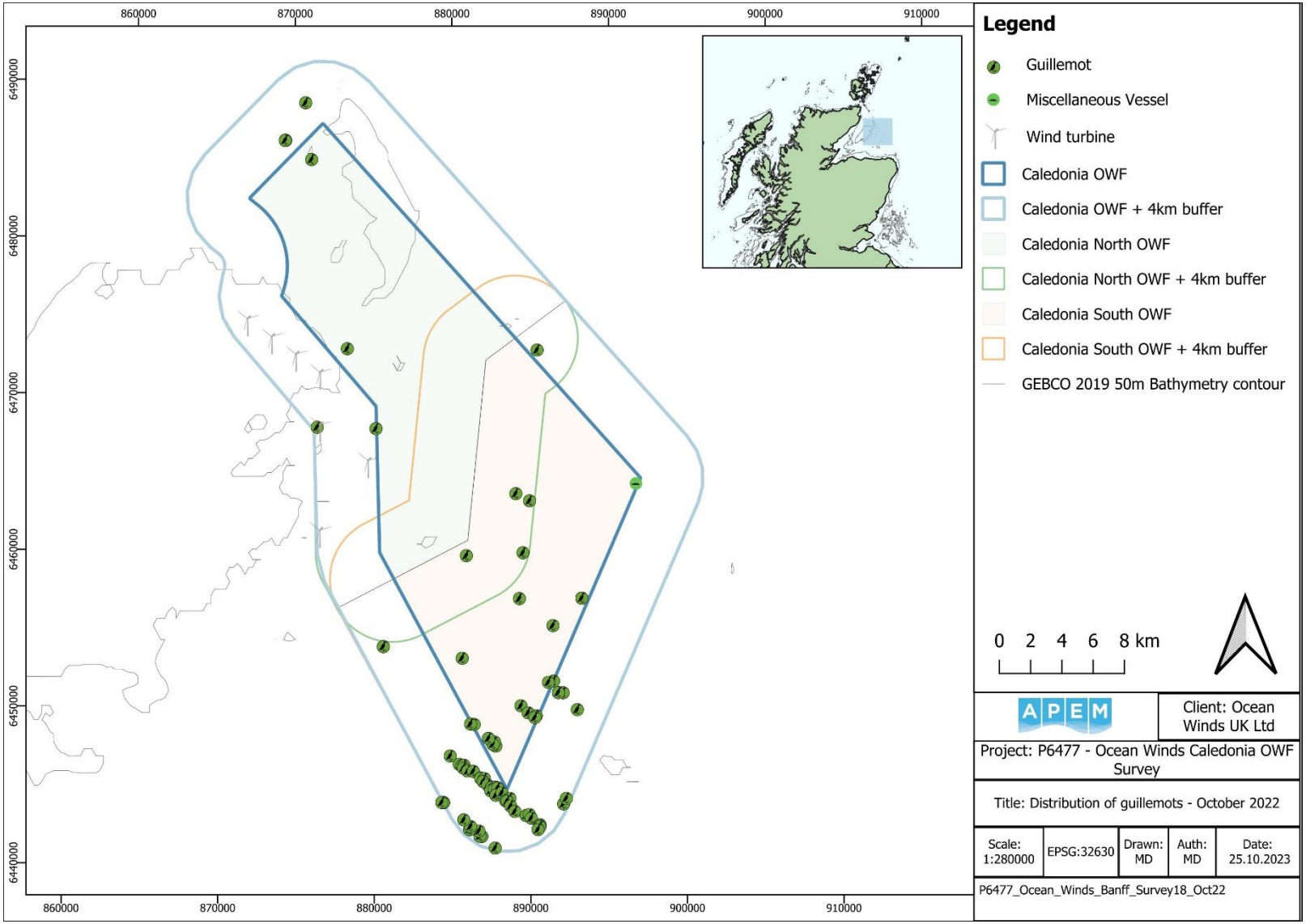



**Figure A4.162 Distribution of guillemots recorded in the Survey Area in October 2022**

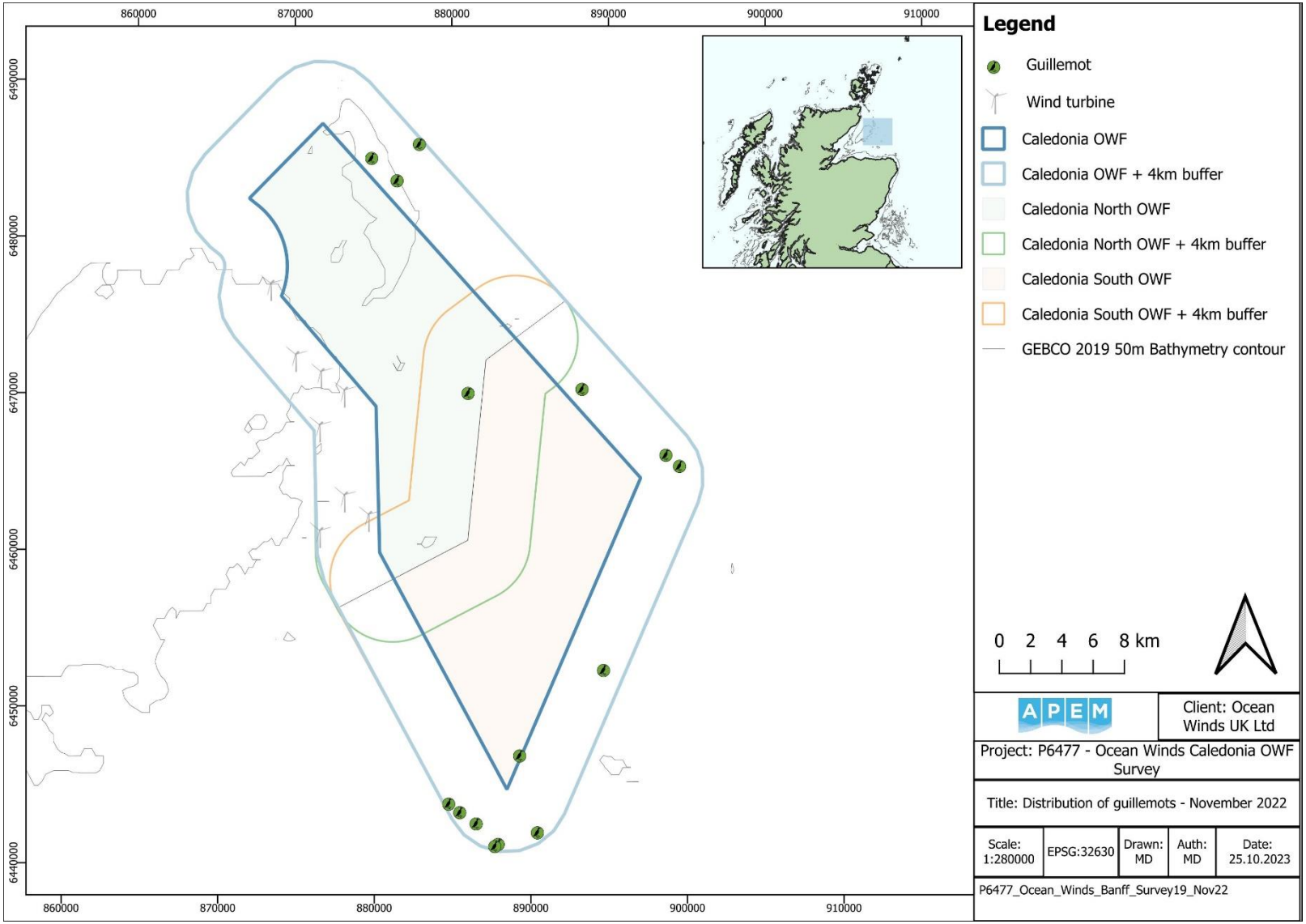



**Figure A4.163 Distribution of guillemots recorded in the Survey Area in November 2022**

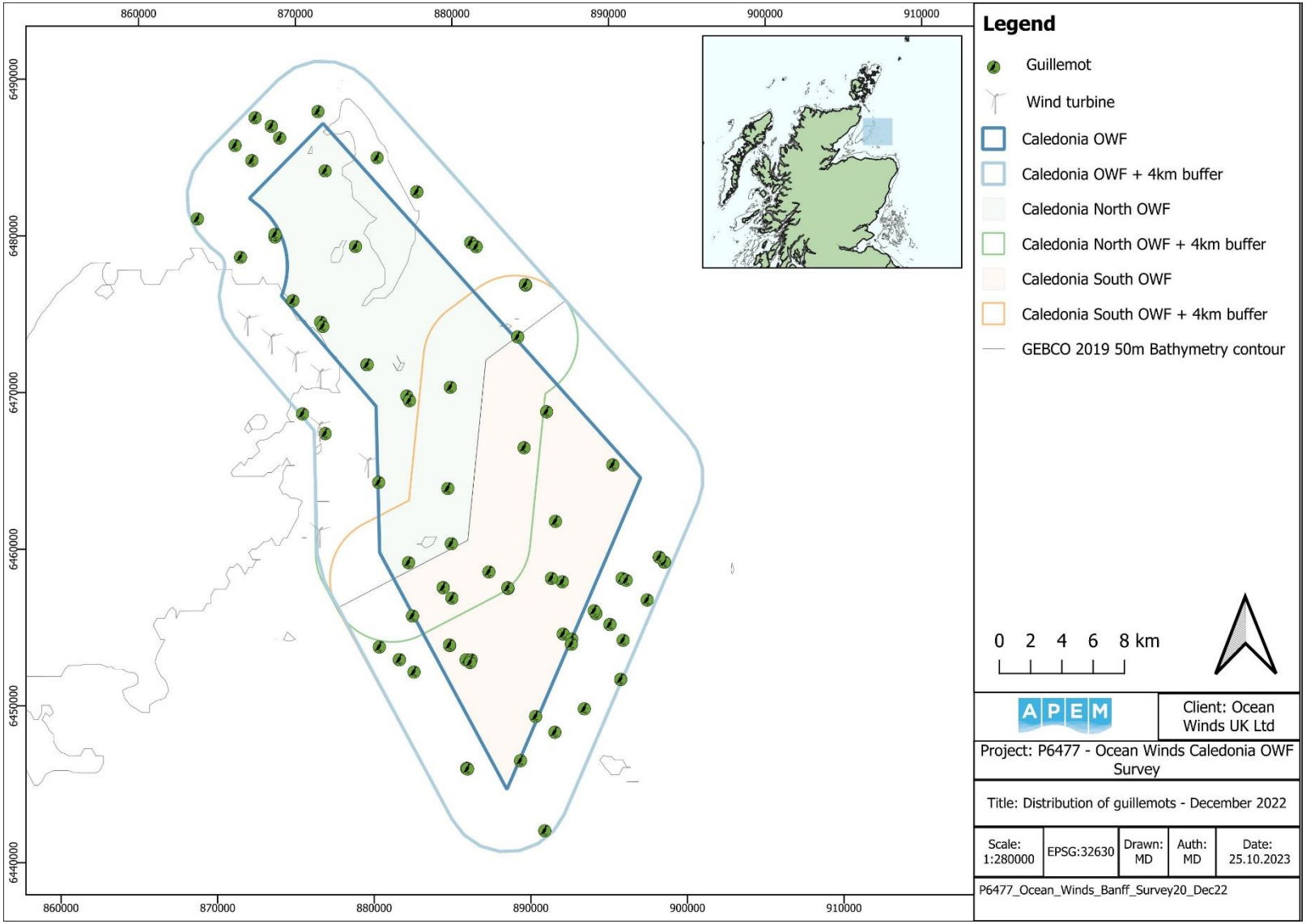



**Figure A4.164 Distribution of guillemots recorded in the Survey Area in December 2022**

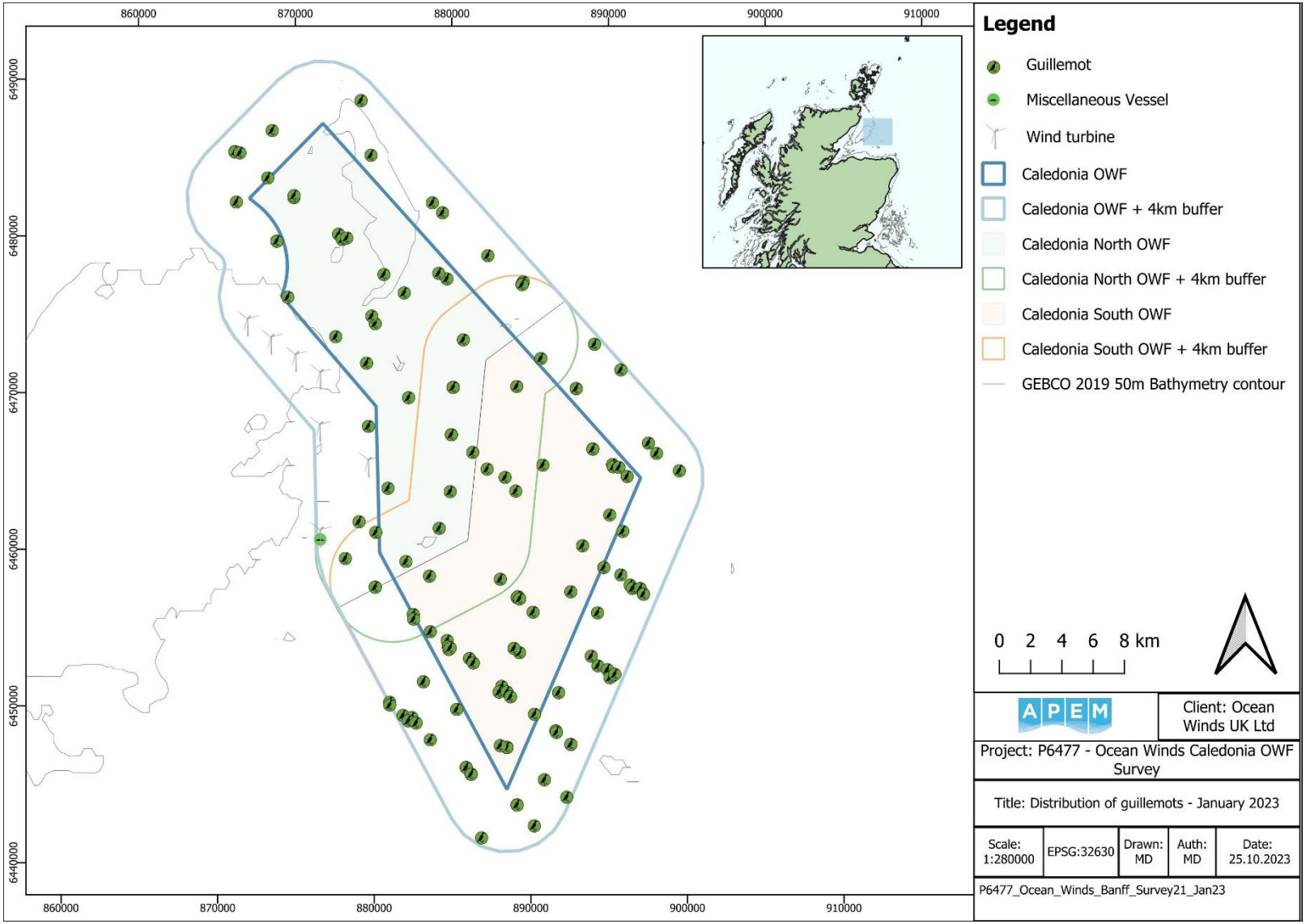



**Figure A4.165 Distribution of guillemots recorded in the Survey Area in January 2023**

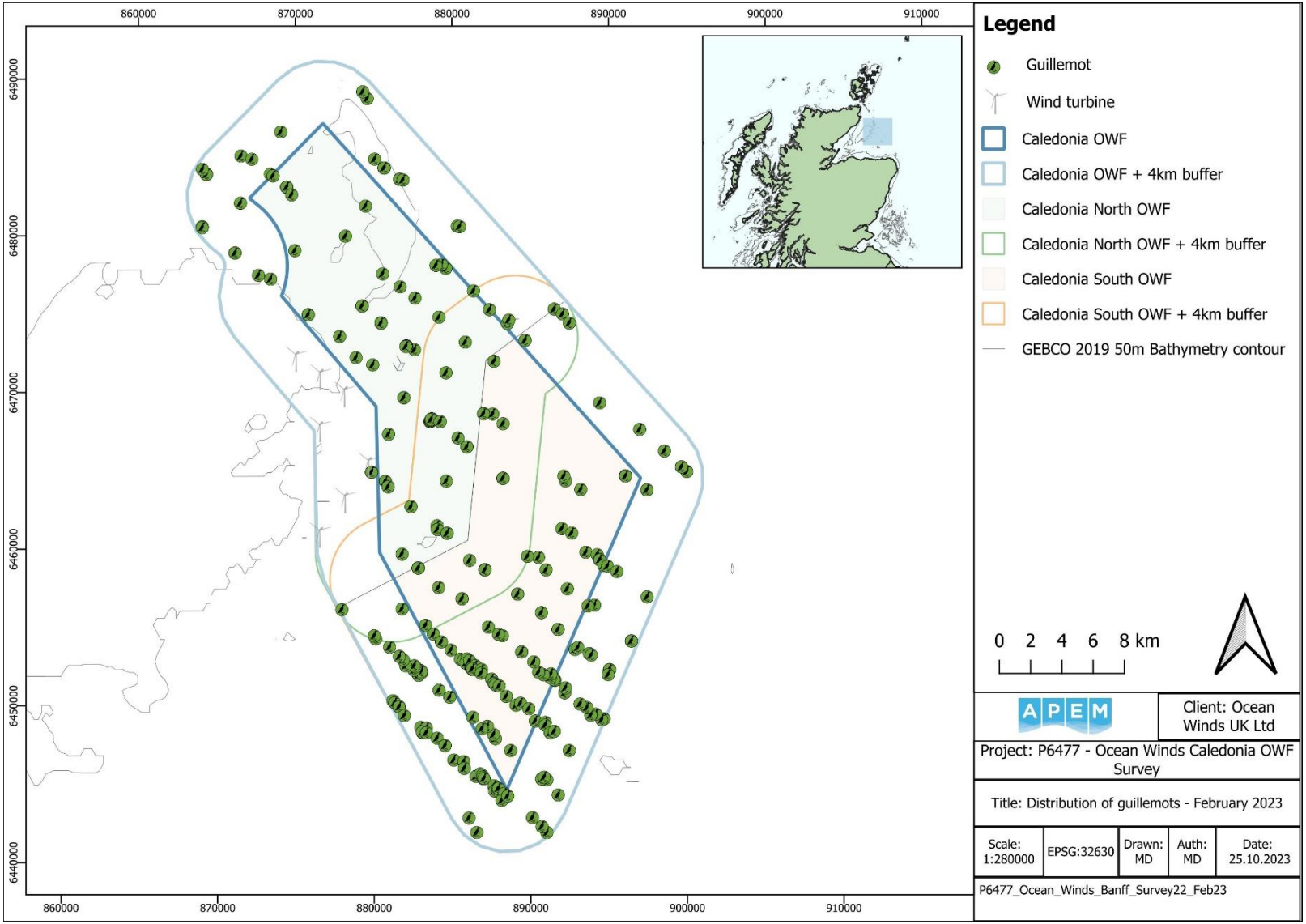



**Figure A4.166 Distribution of guillemots recorded in the Survey Area in February 2023**

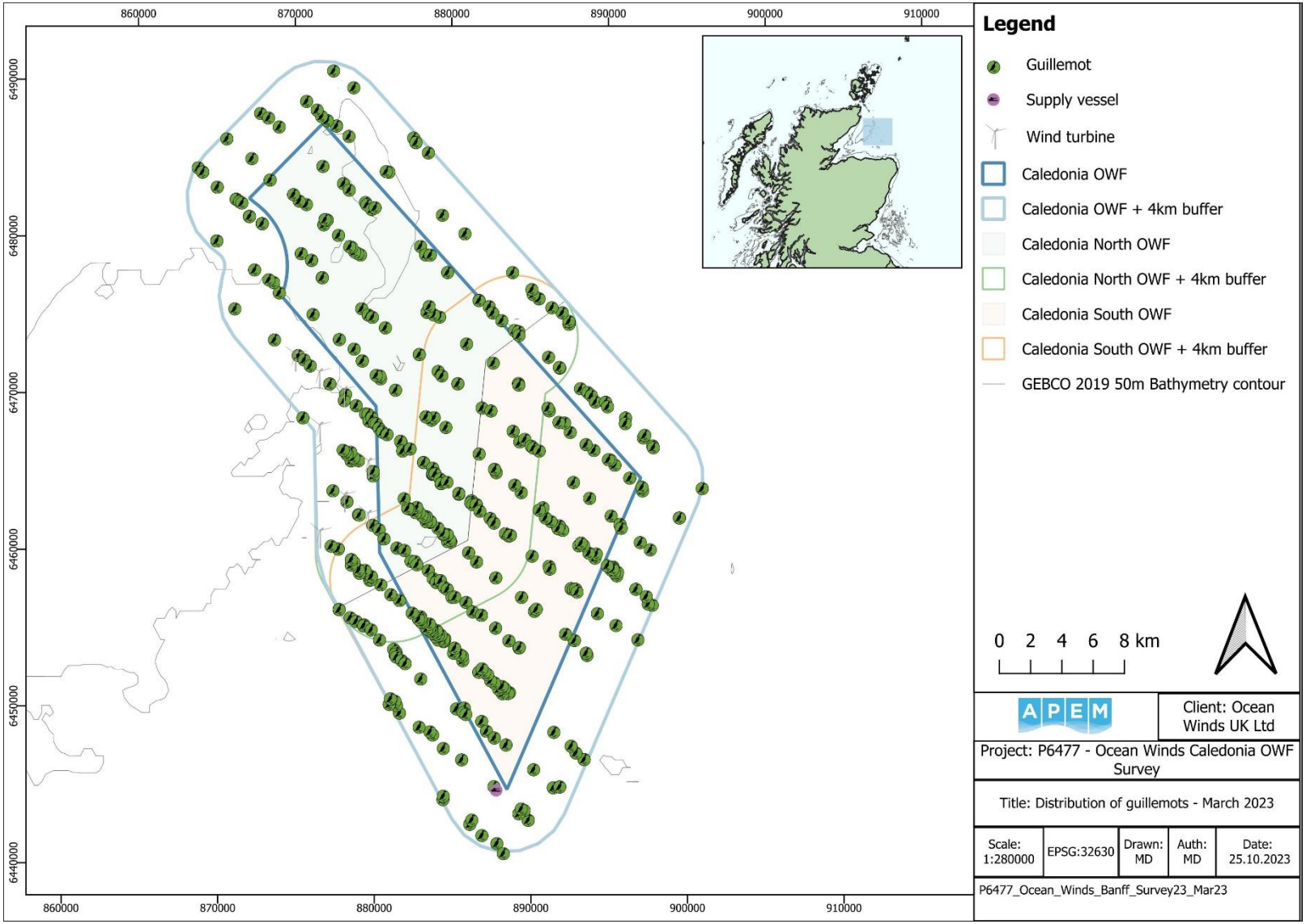



**Figure A4.167 Distribution of guillemots recorded in the Survey Area in March 2023**

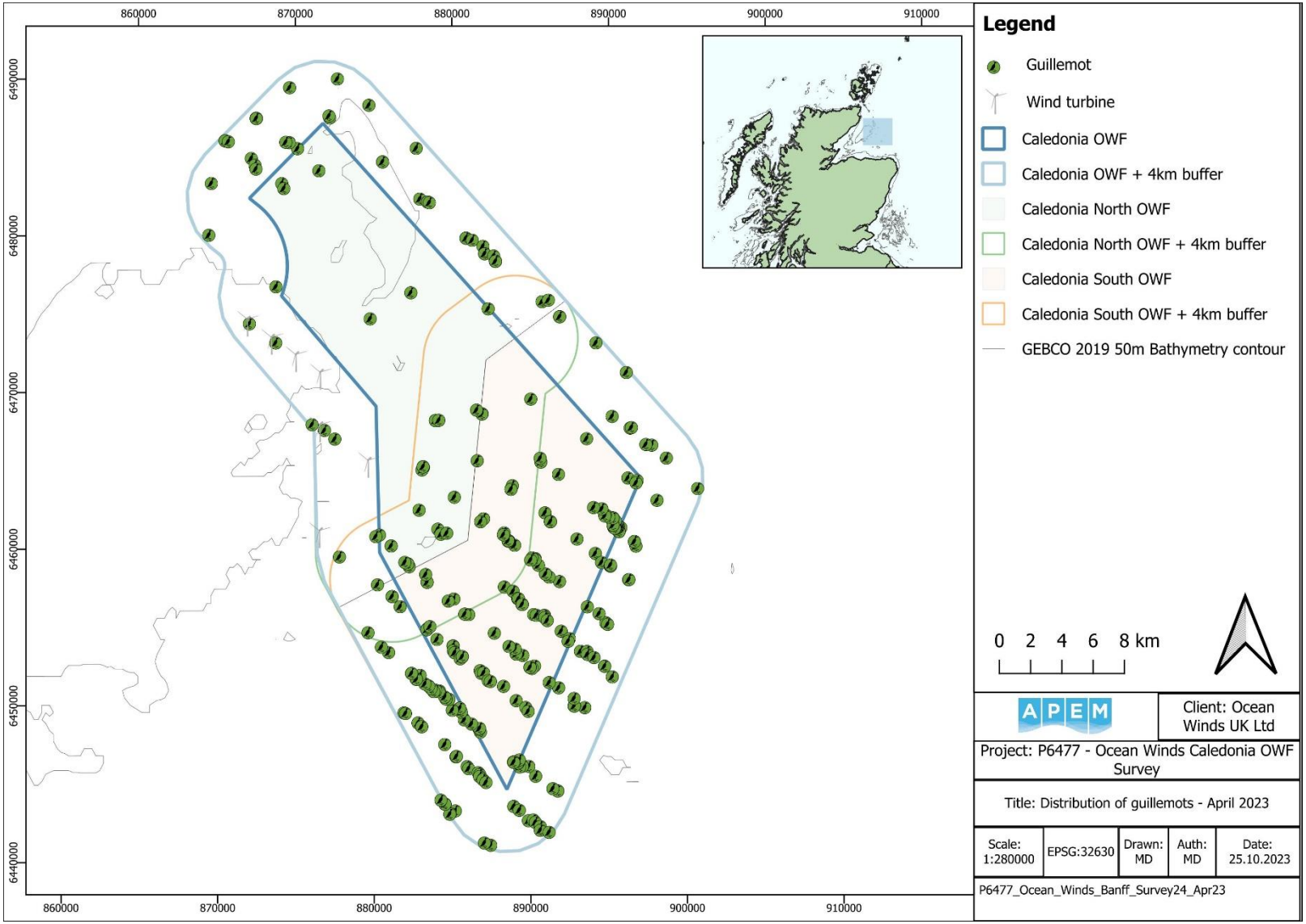



**Figure A4.168 Distribution of guillemots recorded in the Survey Area in April 2023**

## Razorbill

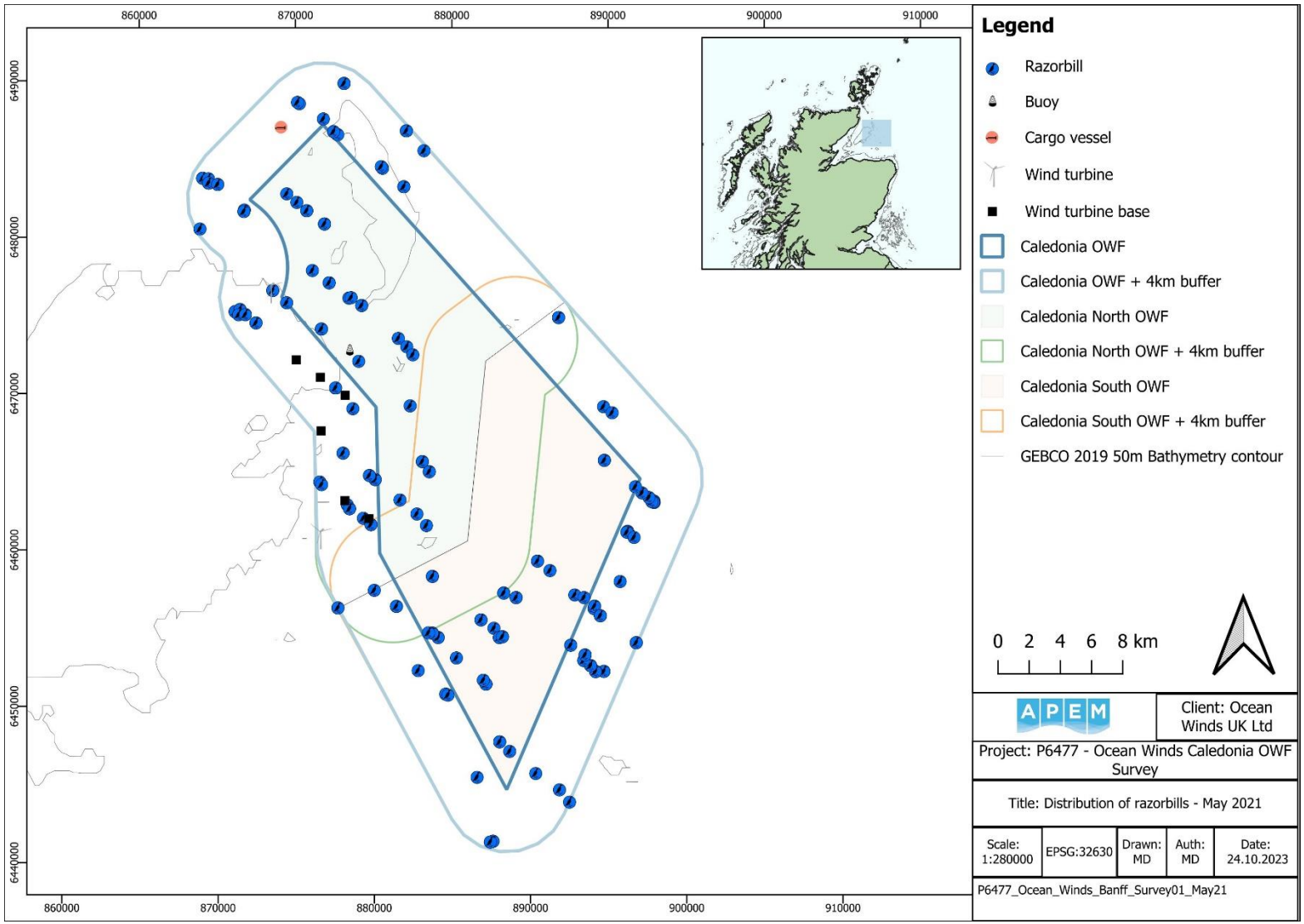



**Figure A4.169 Distribution of razorbills recorded in the Survey Area in May 2021**

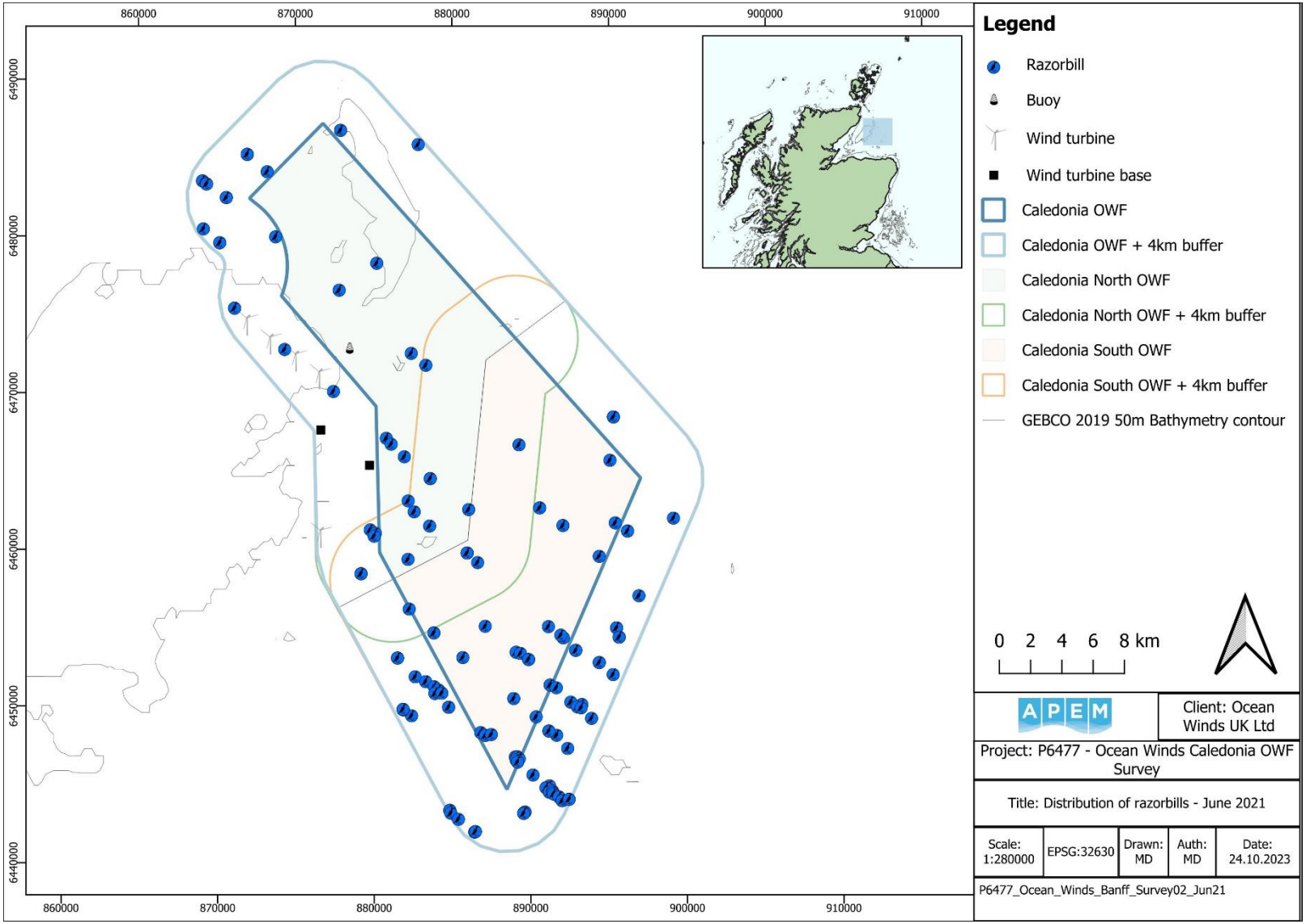



**Figure A4.170 Distribution of razorbills recorded in the Survey Area in June 2021**

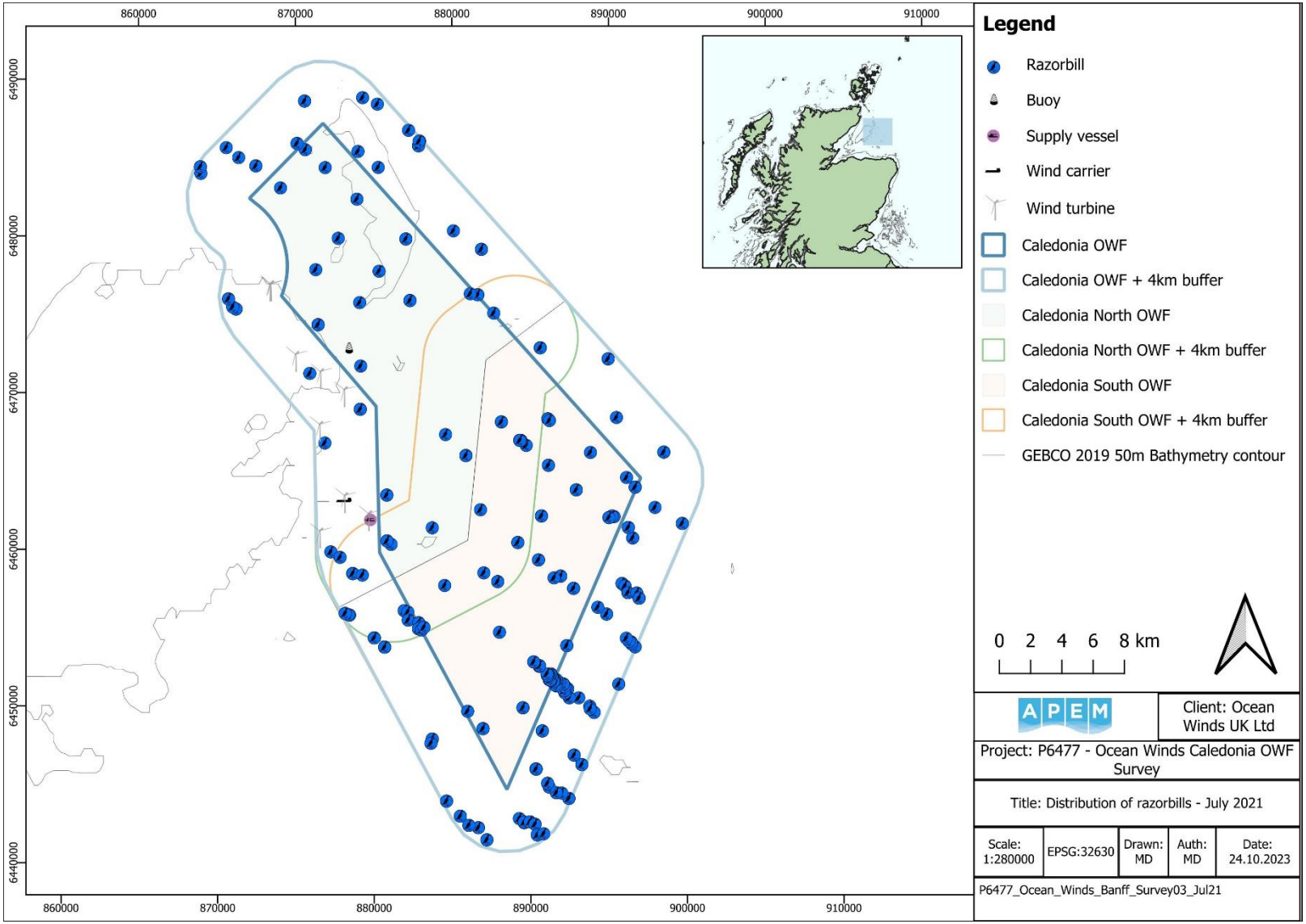



**Figure A4.171 Distribution of razorbills recorded in the Survey Area in July 2021**

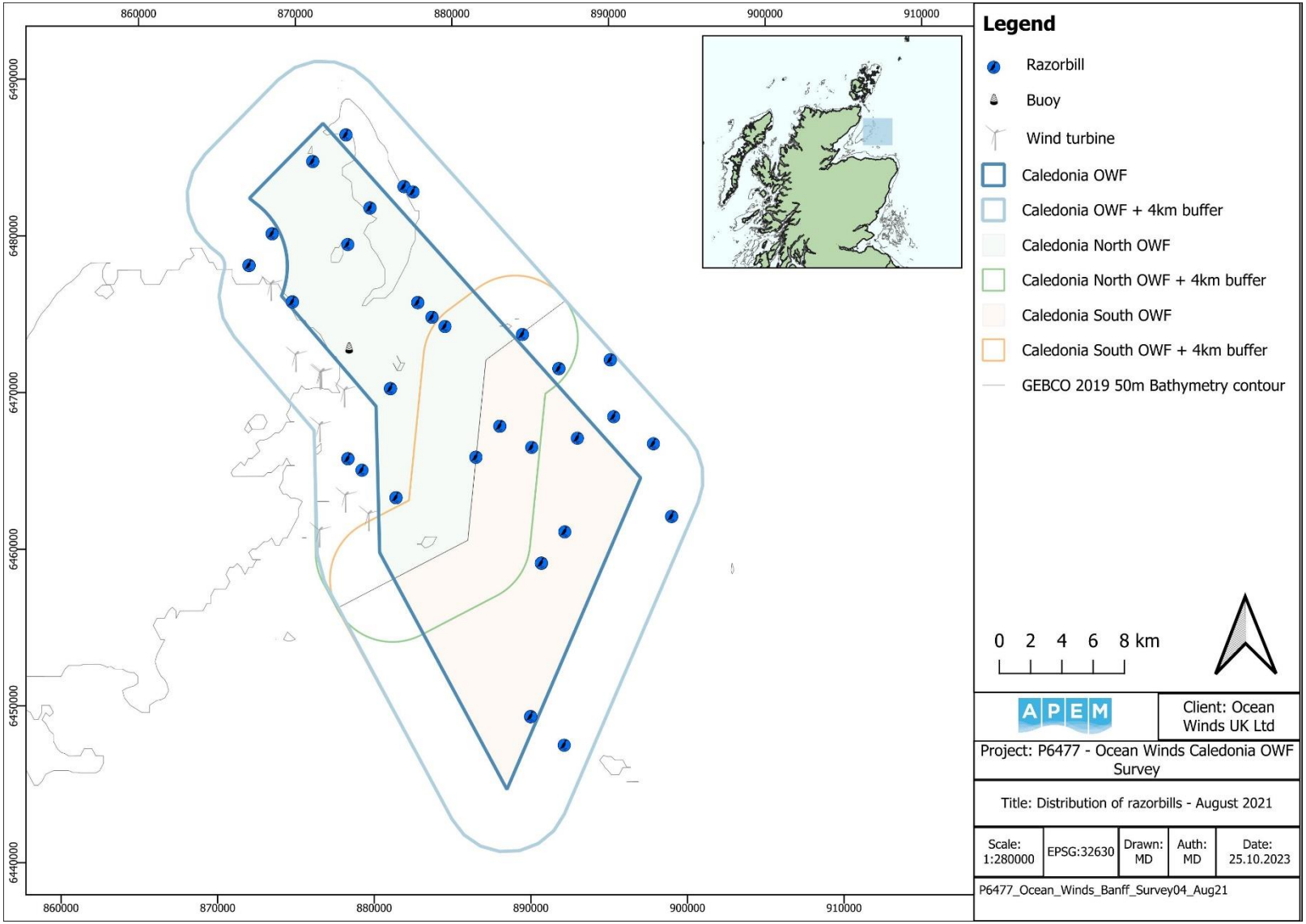



**Figure A4.172 Distribution of razorbills recorded in the Survey Area in August 2021**

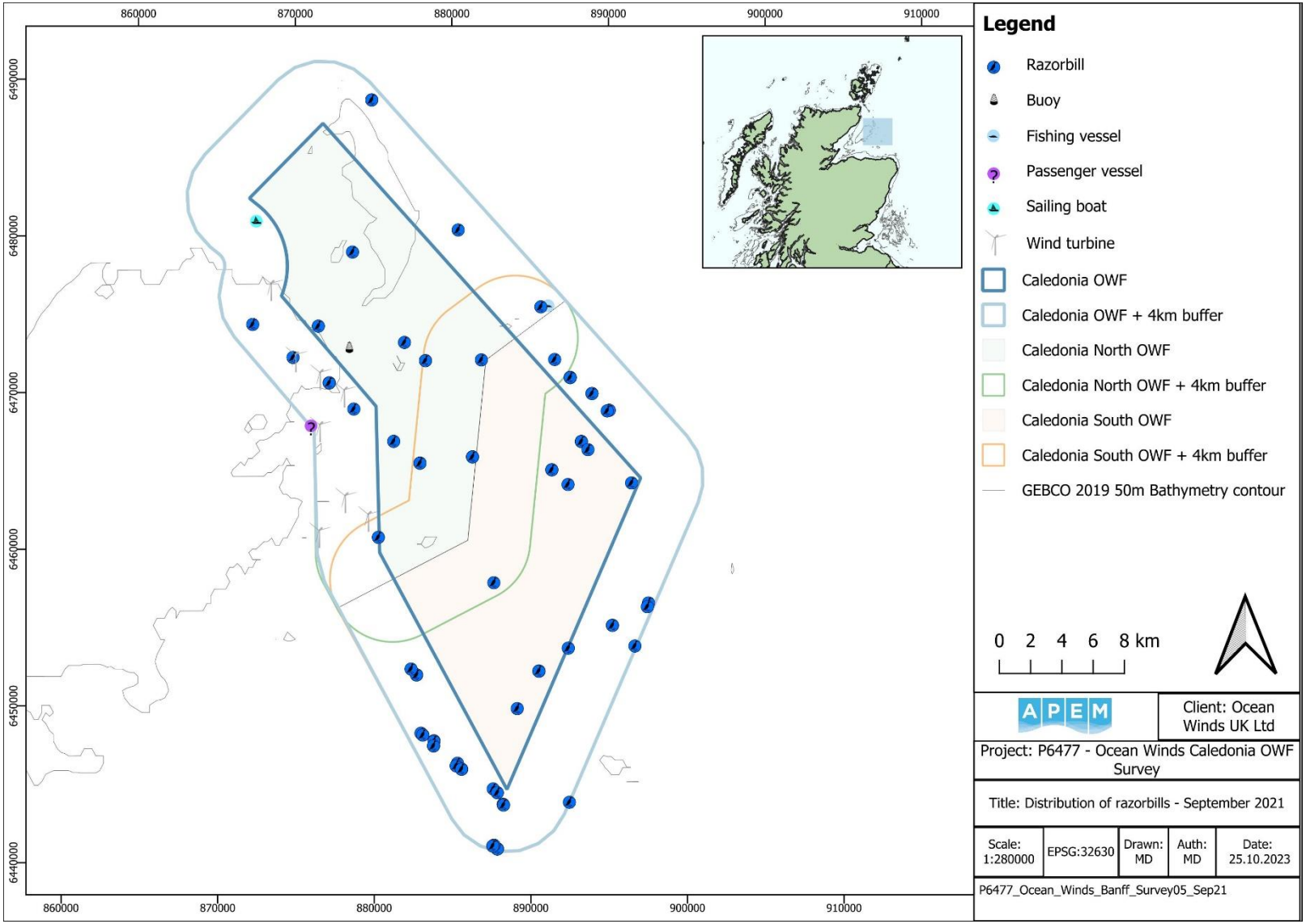



**Figure A4.173 Distribution of razorbills recorded in the Survey Area in September 2021**

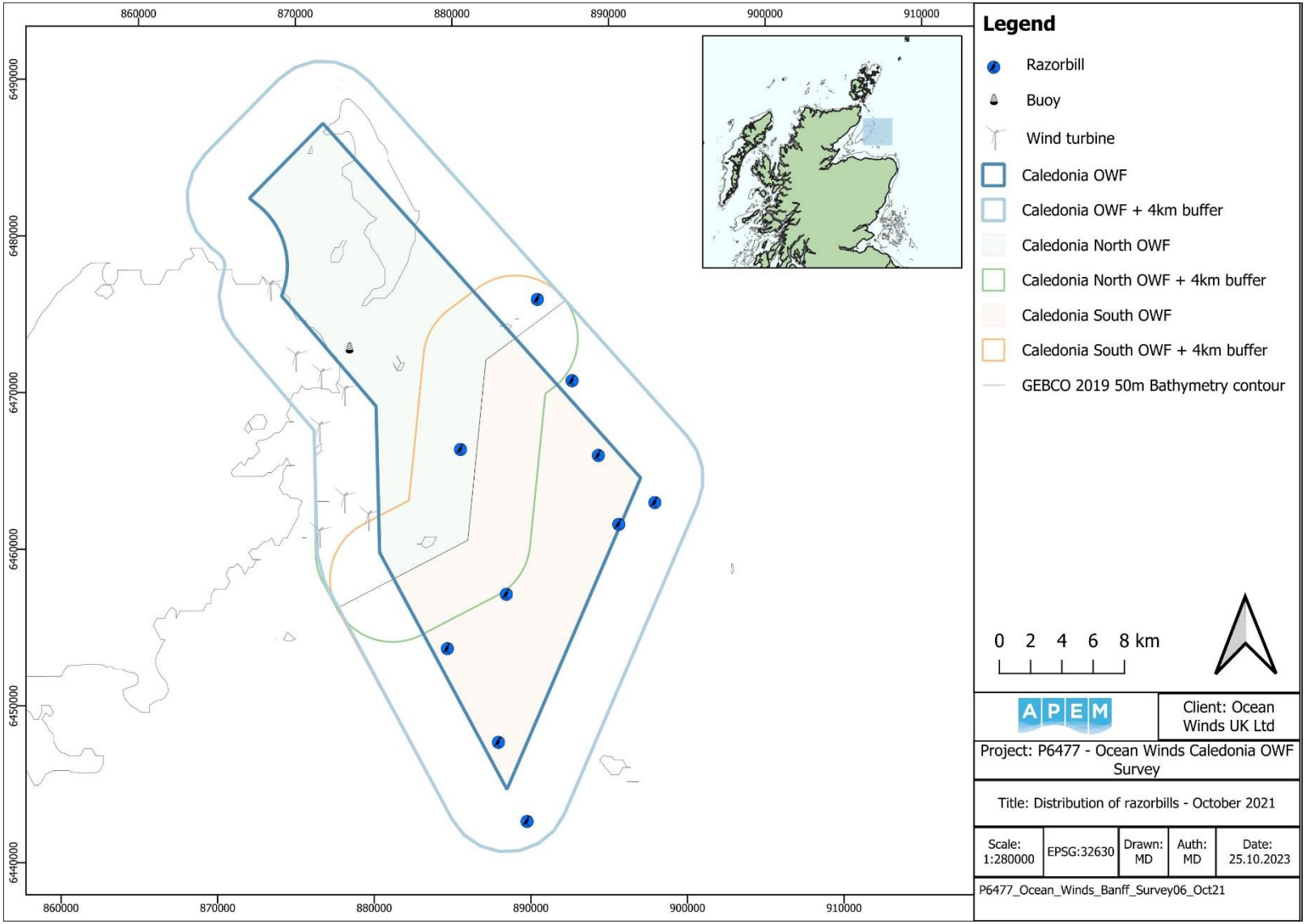



**Figure A4.174 Distribution of razorbills recorded in the Survey Area in October 2021**

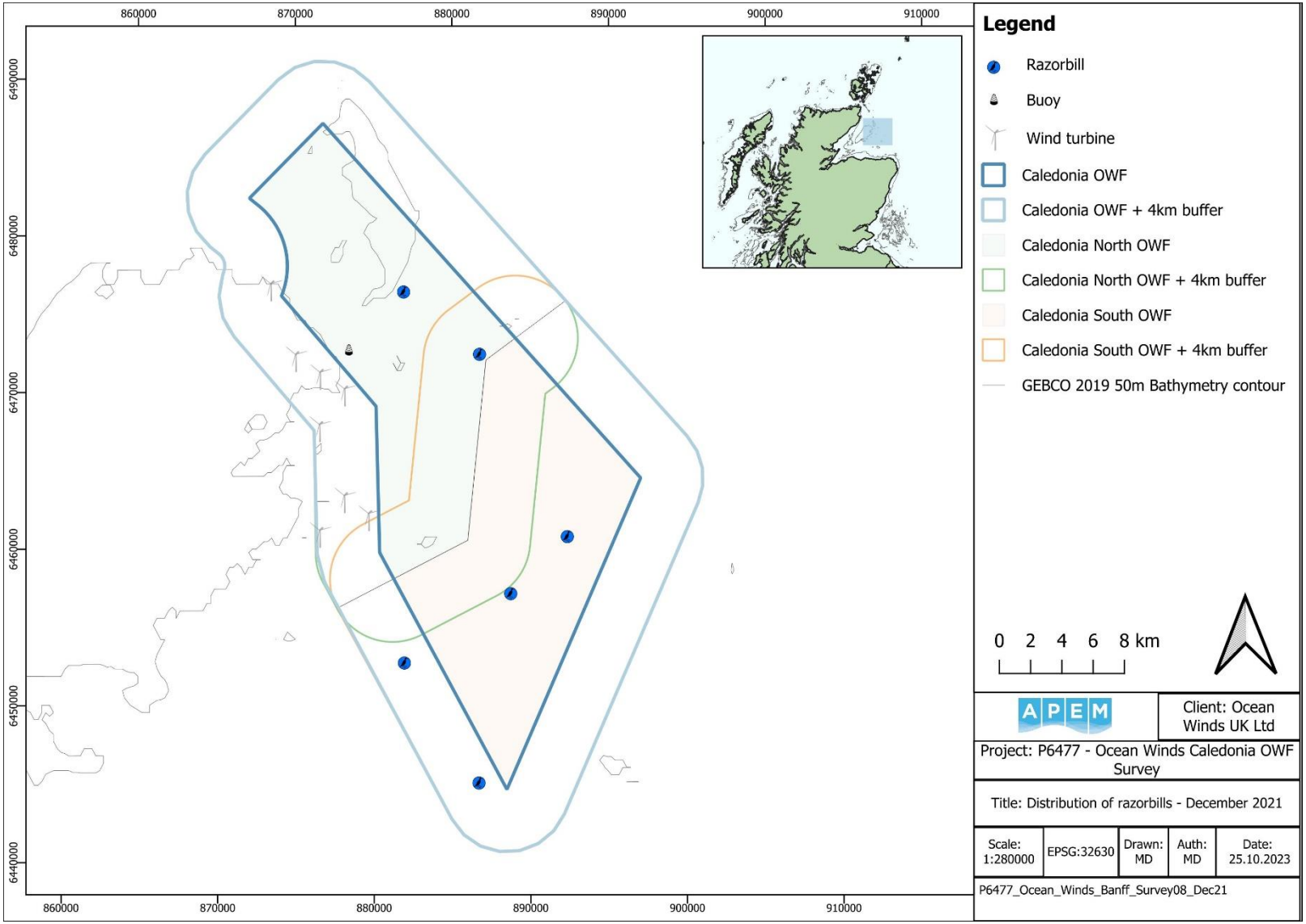



**Figure A4.175 Distribution of razorbills recorded in the Survey Area in December 2021**

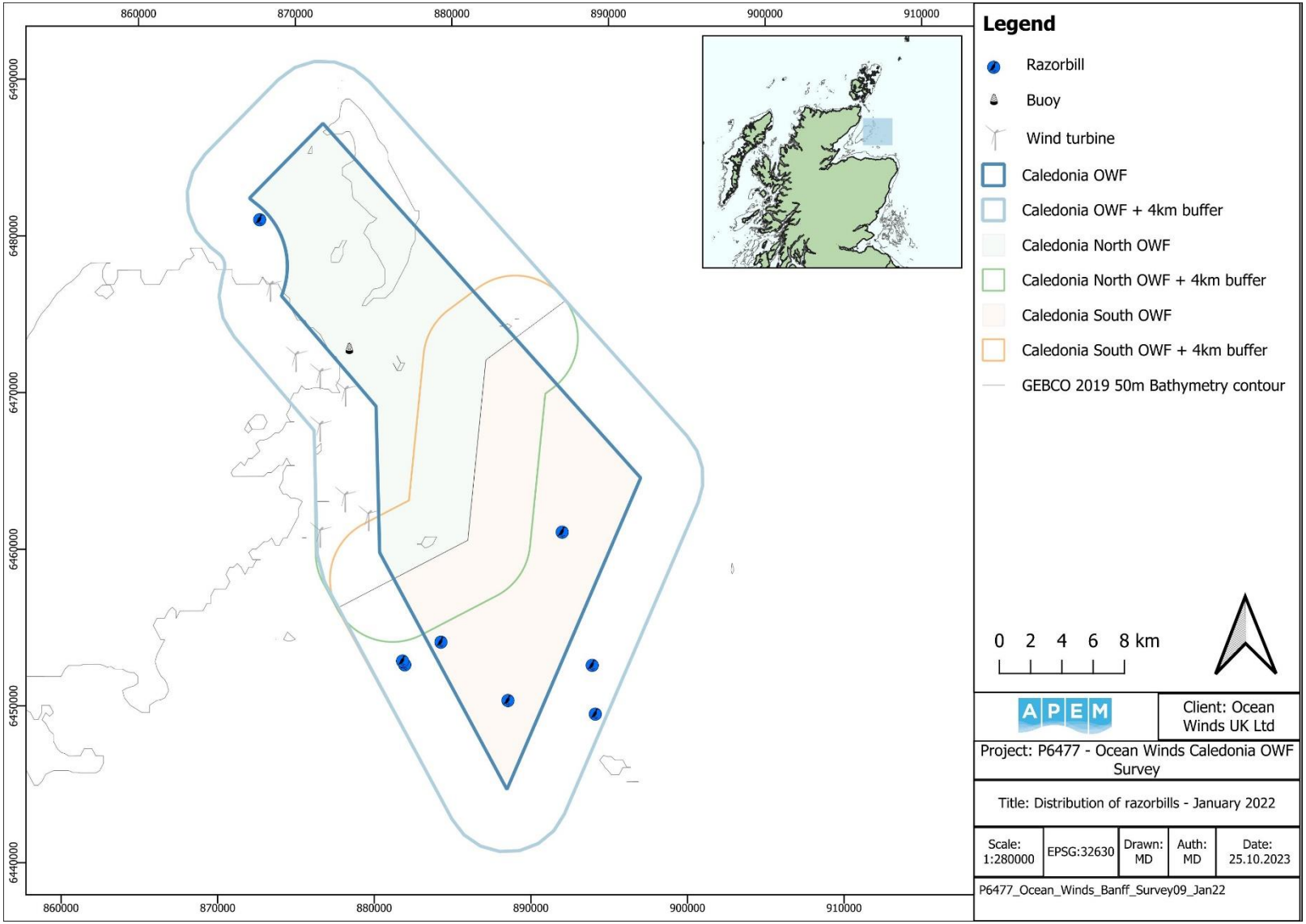



**Figure A4.176 Distribution of razorbills recorded in the Survey Area in January 2022**

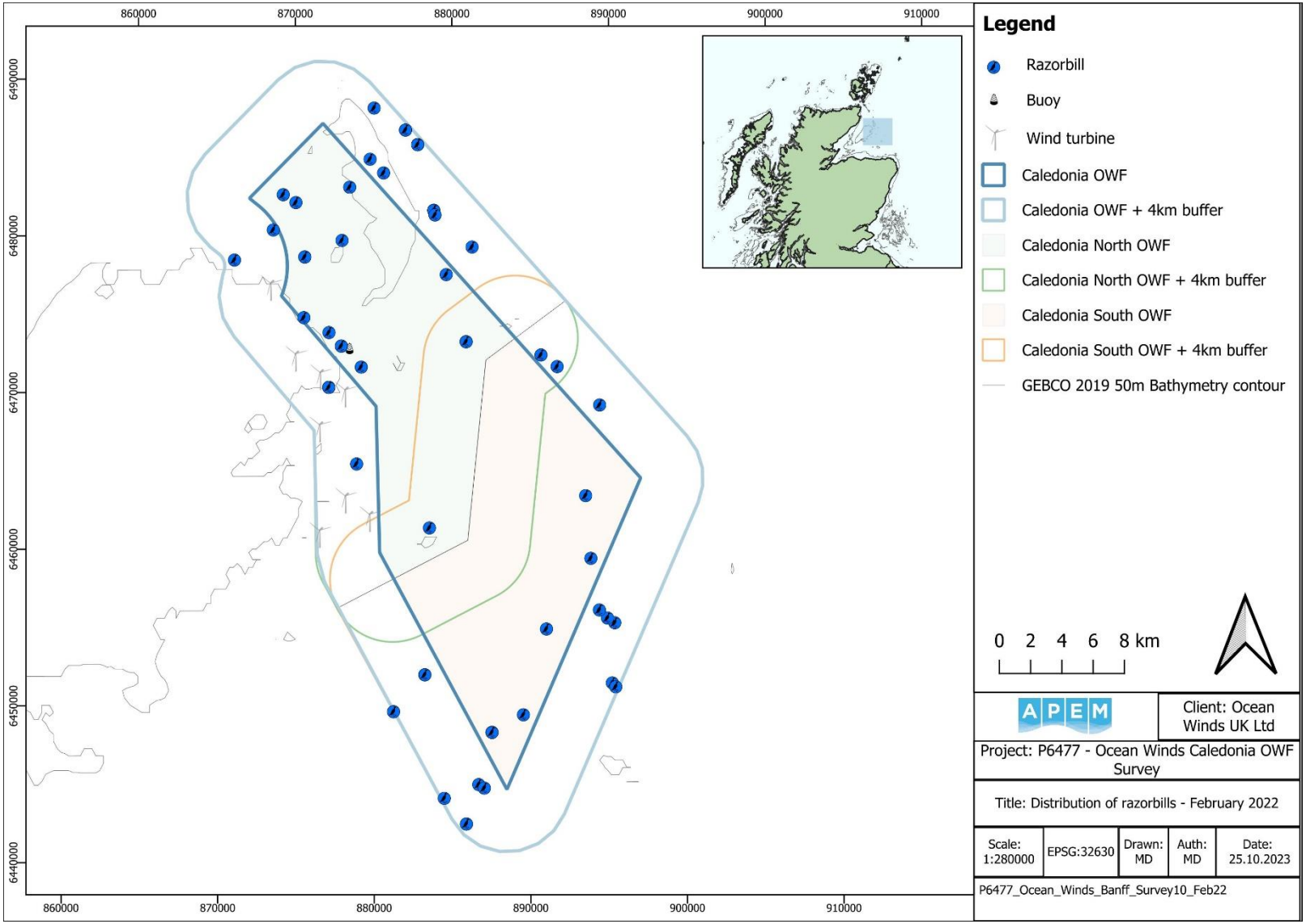



**Figure A4.177 Distribution of razorbills recorded in the Survey Area in February 2022**

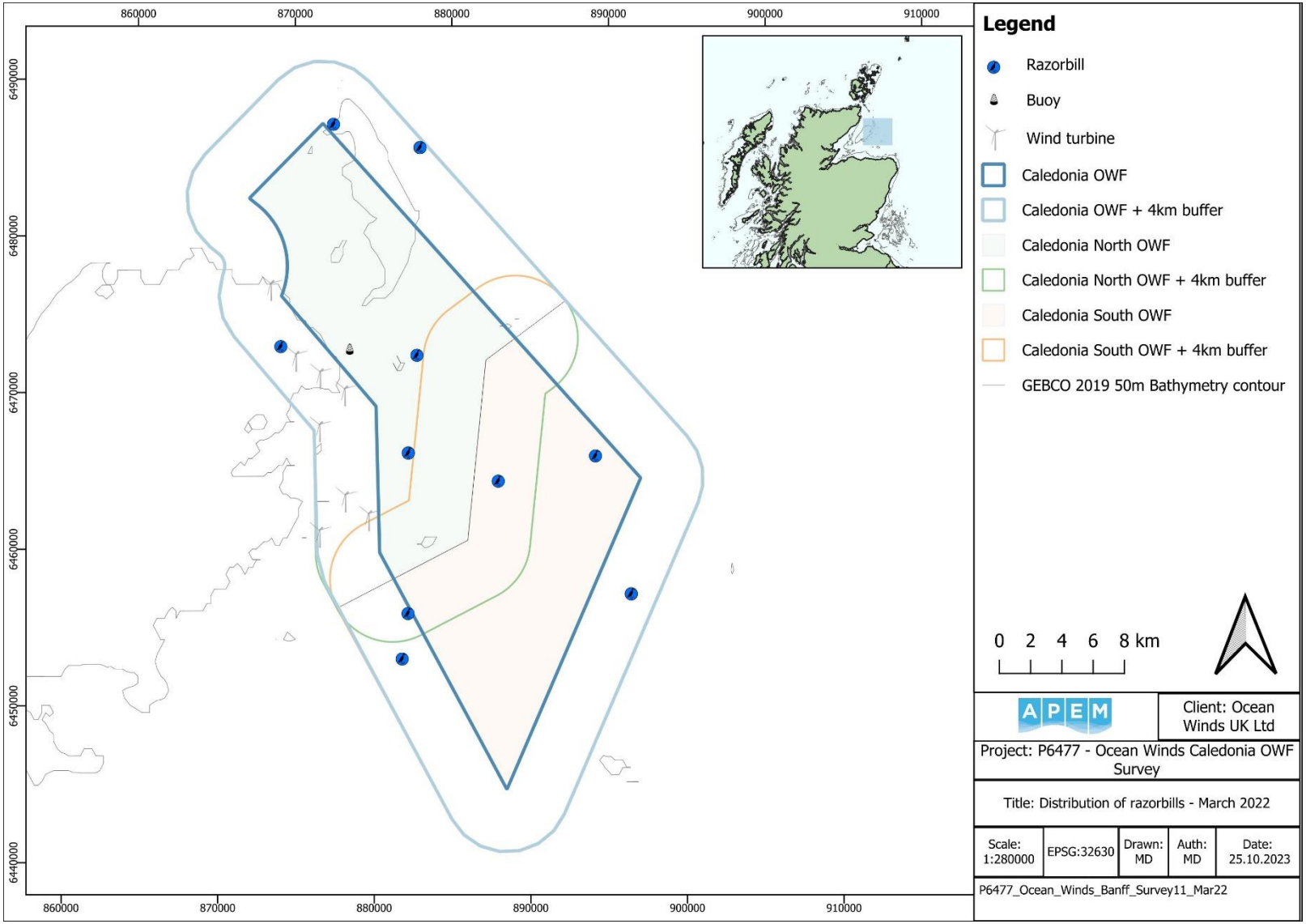



**Figure A4.178 Distribution of razorbills recorded in the Survey Area in March 2022**

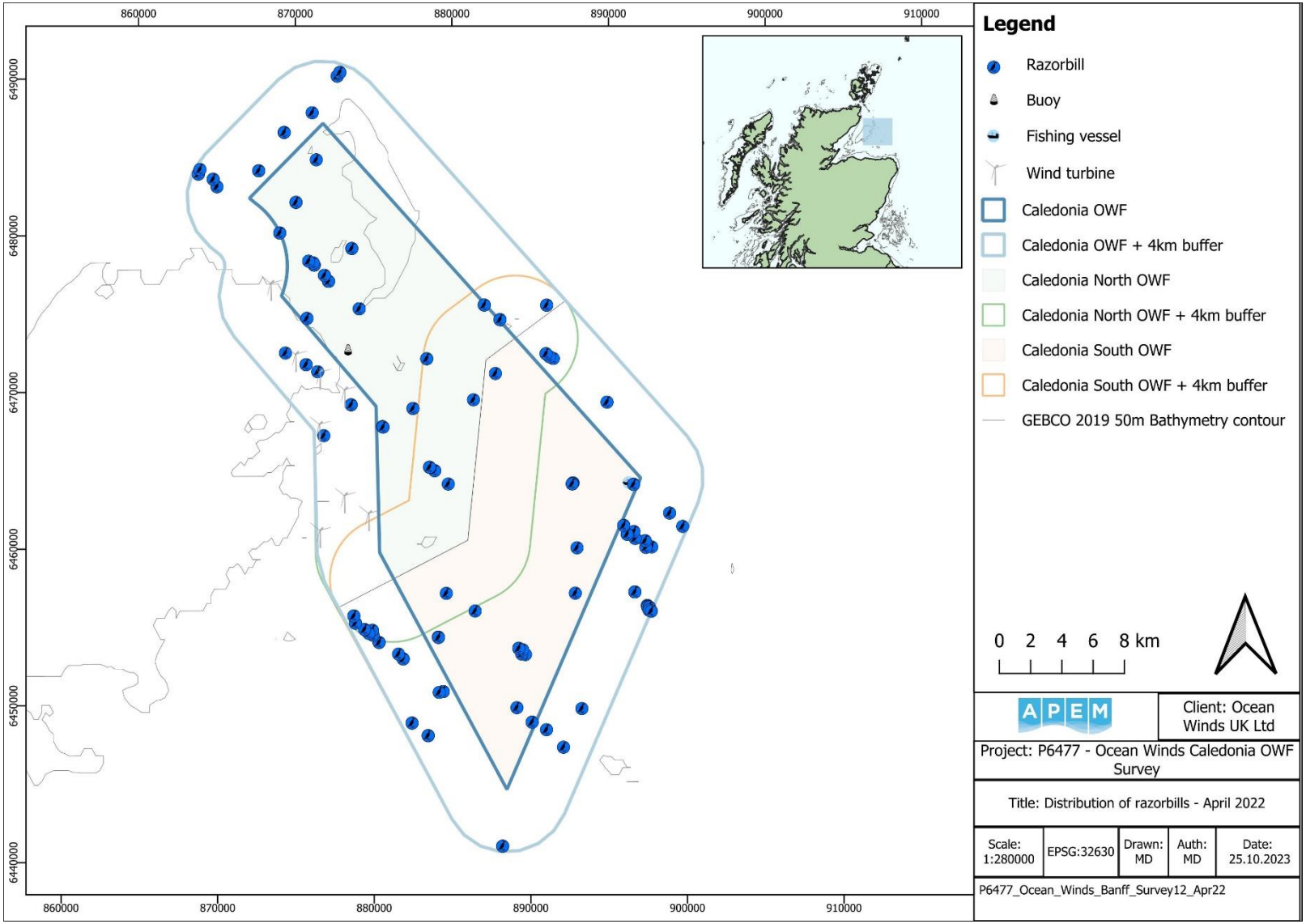



**Figure A4.179 Distribution of razorbills recorded in the Survey Area in April 2022**

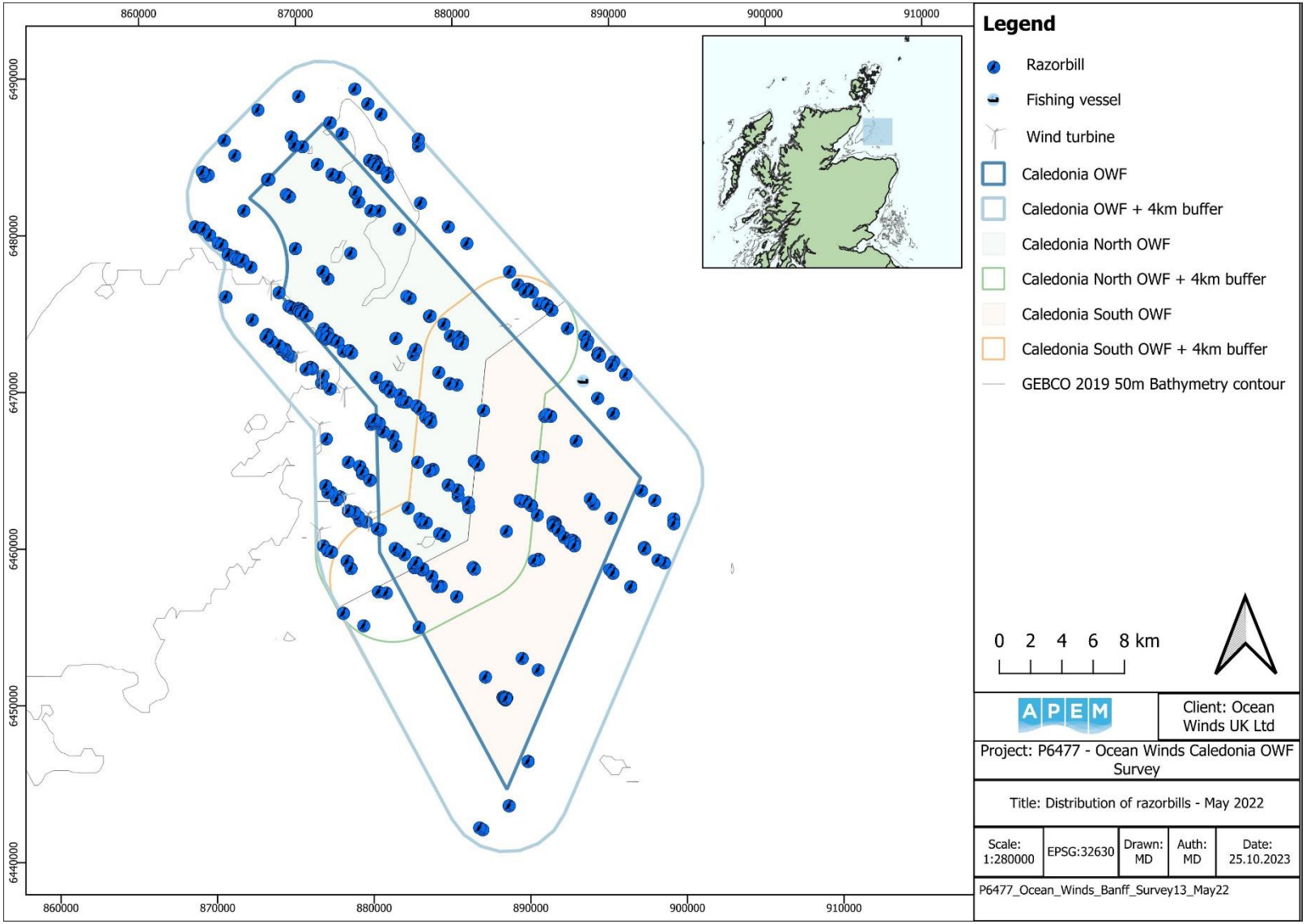



**Figure A4.180 Distribution of razorbills recorded in the Survey Area in May 2022**

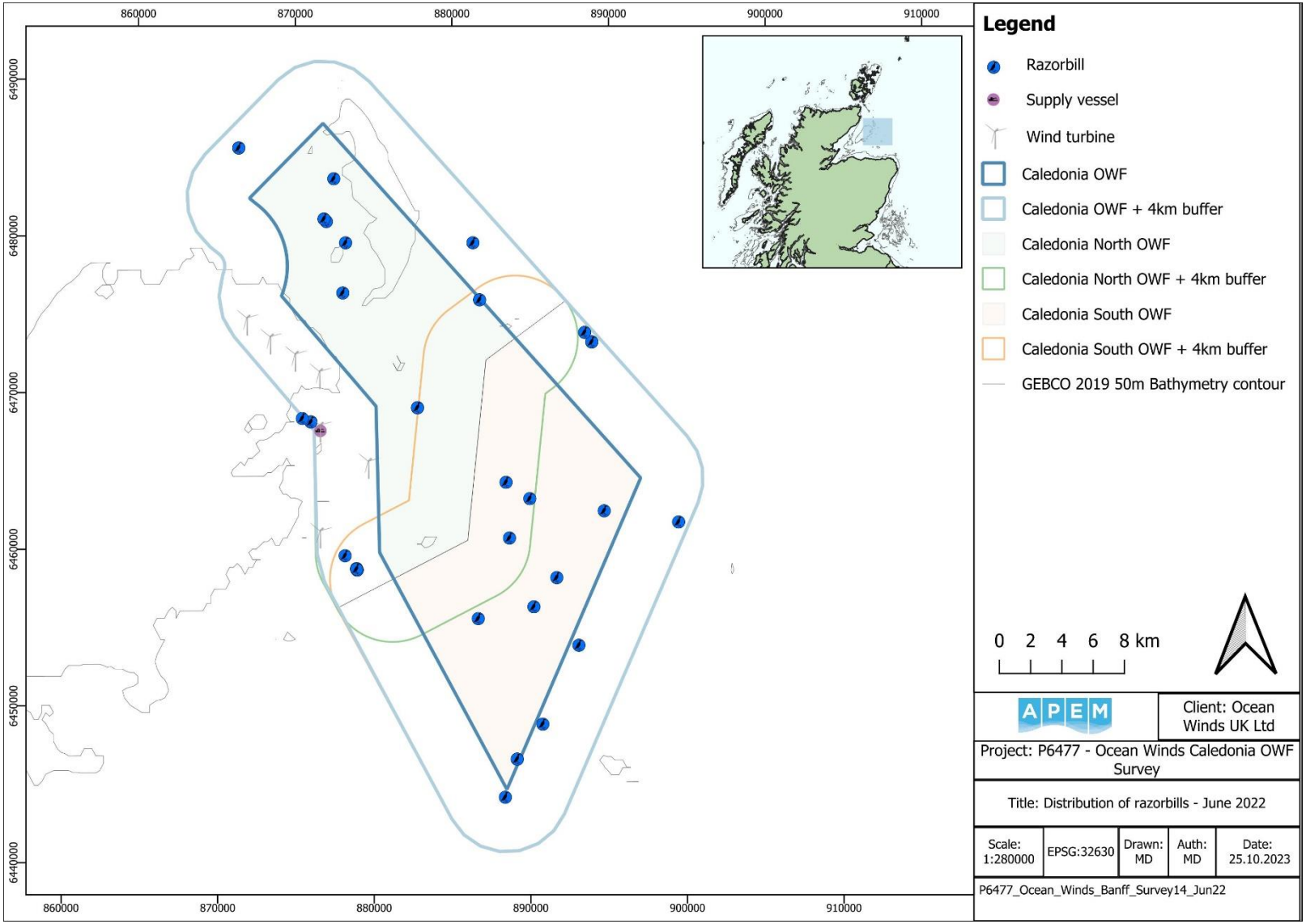



**Figure A4.181 Distribution of razorbills recorded in the Survey Area in June 2022**

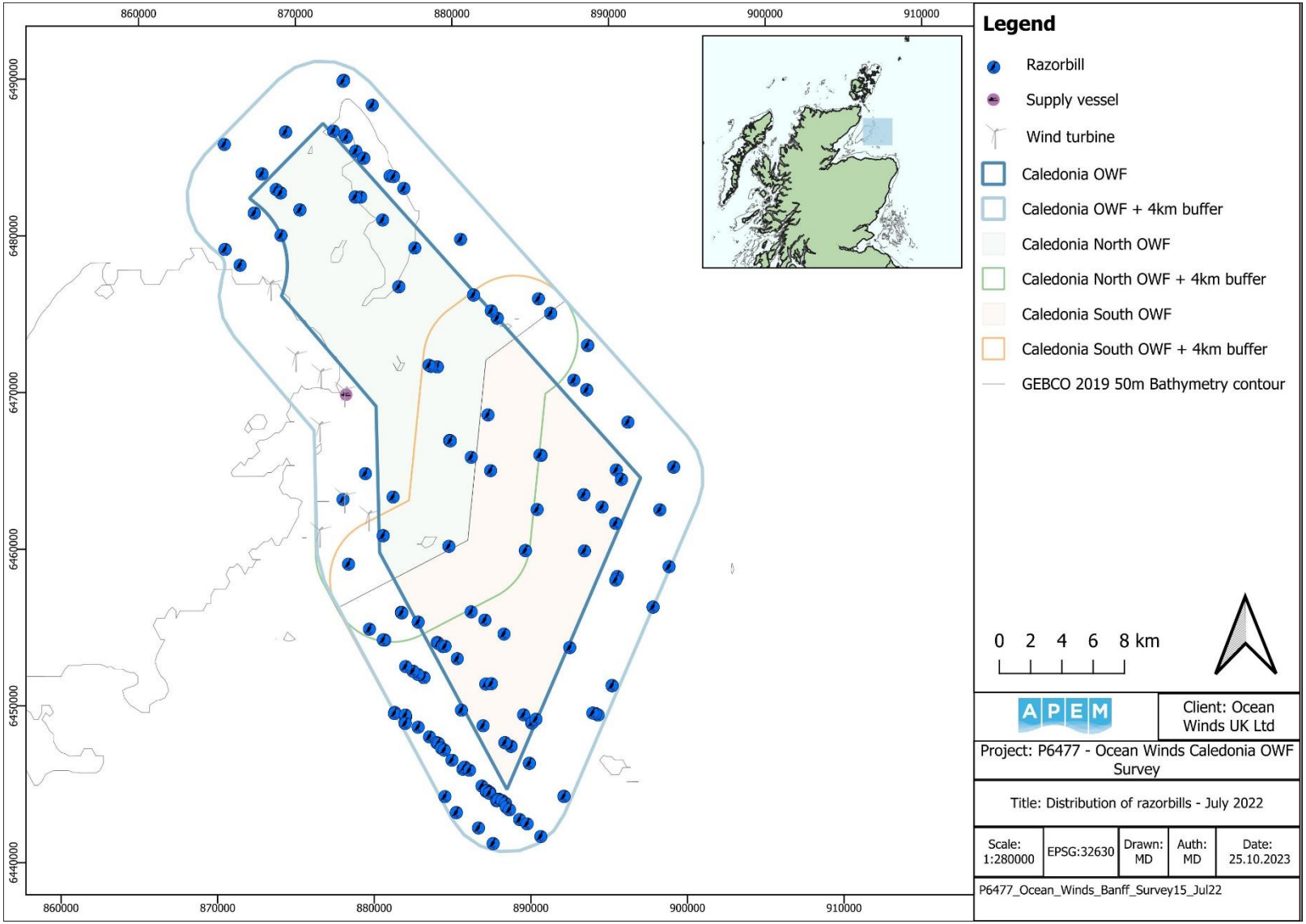



**Figure A4.182 Distribution of razorbills recorded in the Survey Area in July 2022**

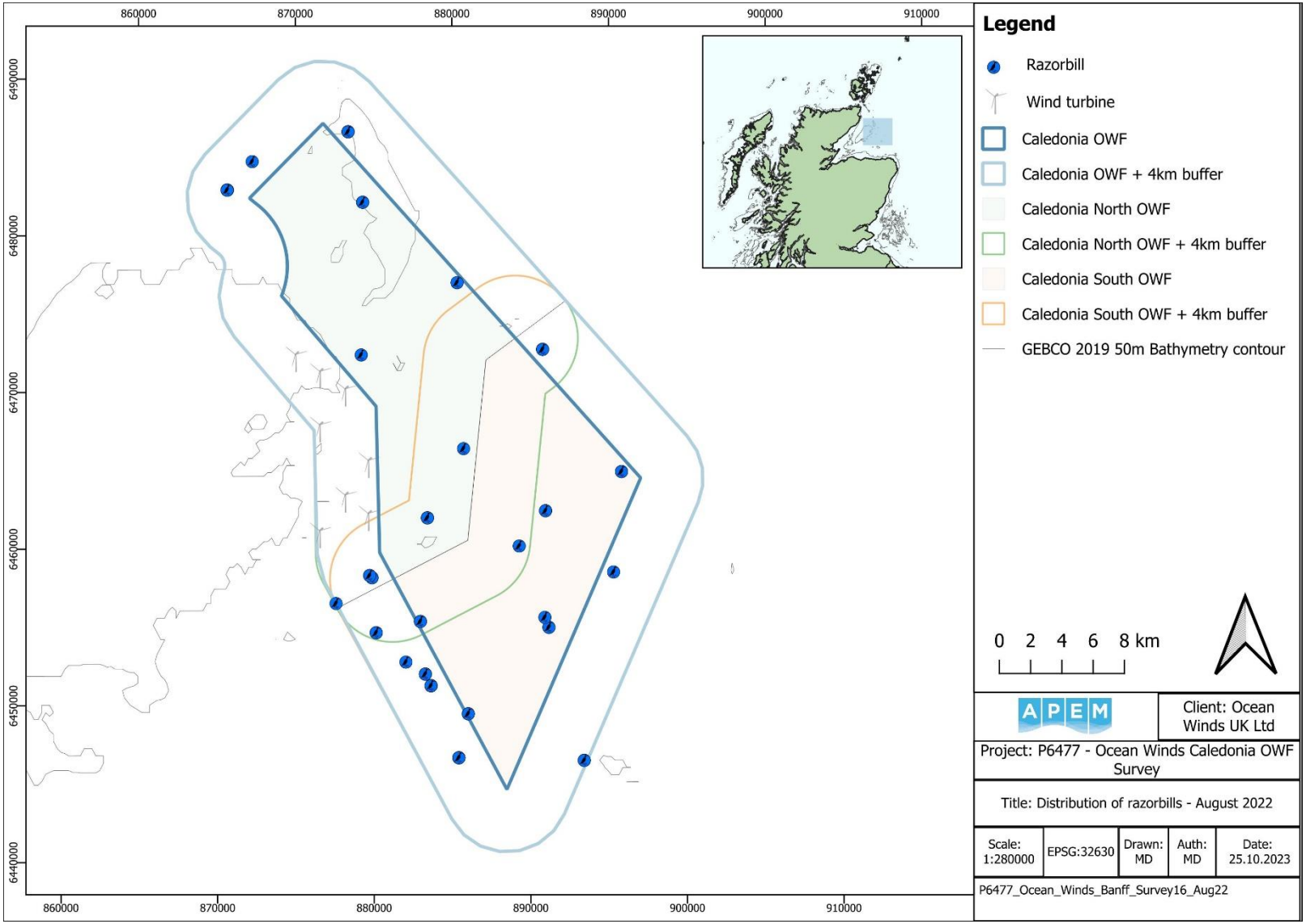



**Figure A4.183 Distribution of razorbills recorded in the Survey Area in August 2022**

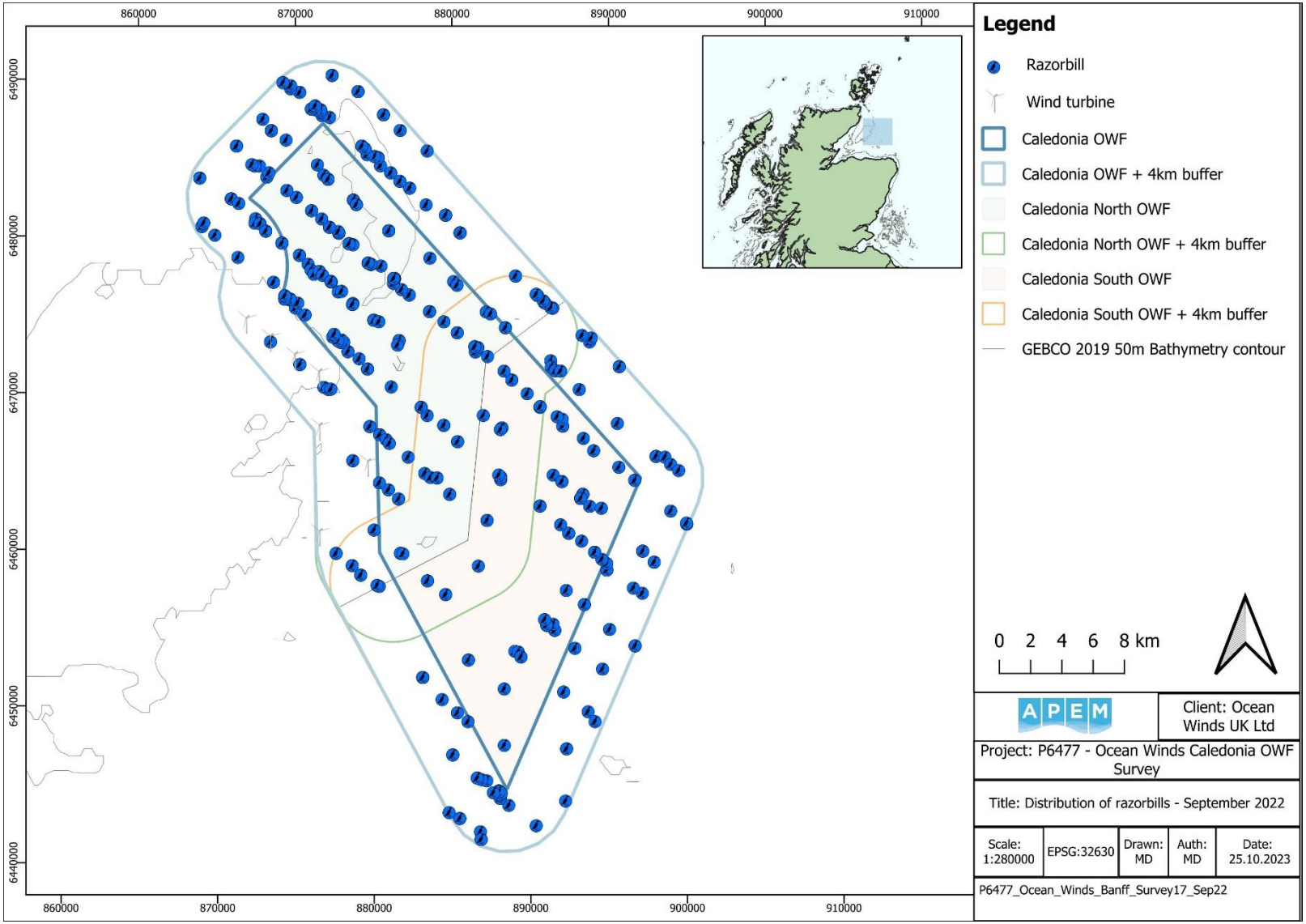



**Figure A4.184 Distribution of razorbills recorded in the Survey Area in September 2022**

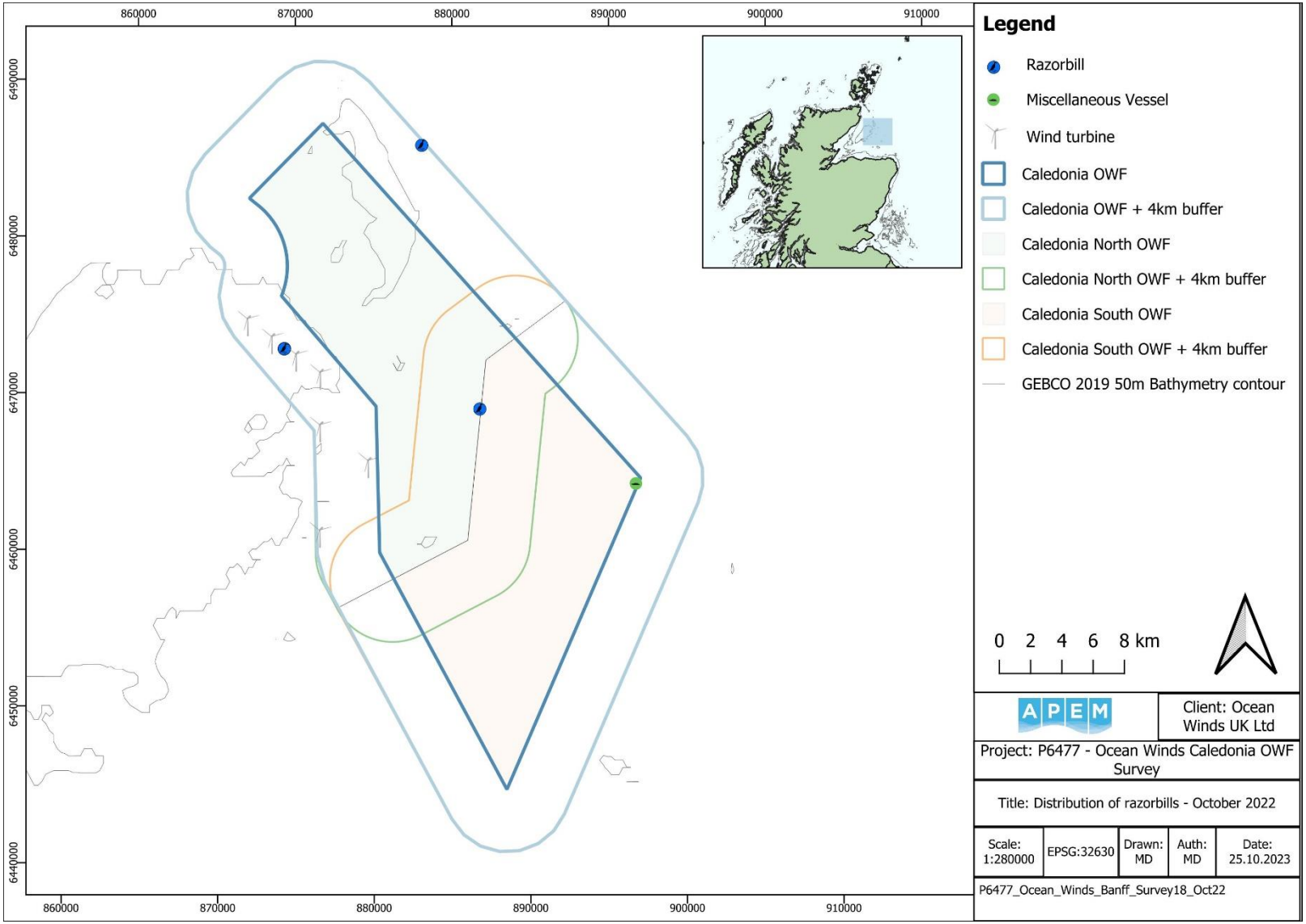



**Figure A4.185 Distribution of razorbills recorded in the Survey Area in October 2022**

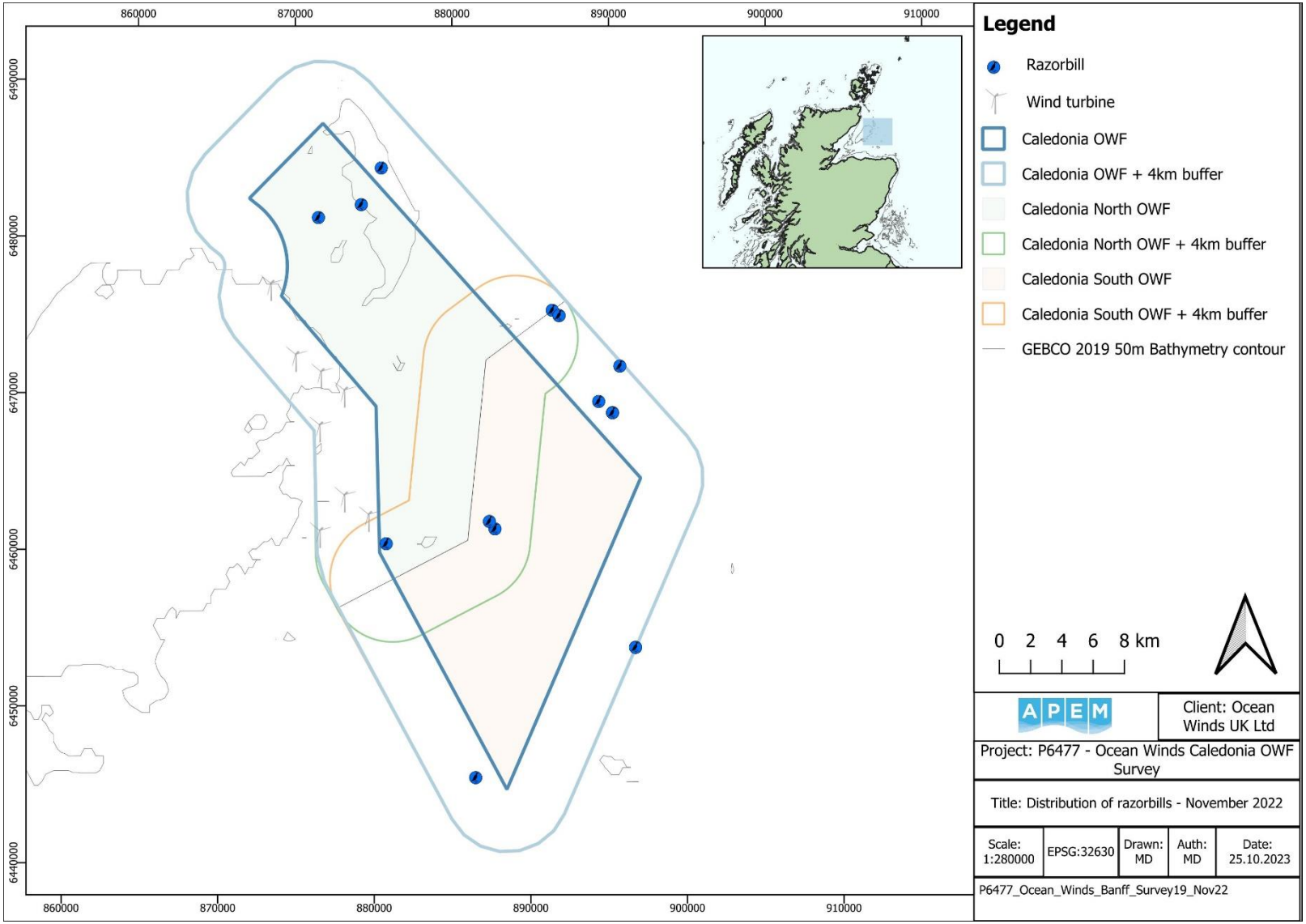



**Figure A4.186 Distribution of razorbills recorded in the Survey Area in November 2022**

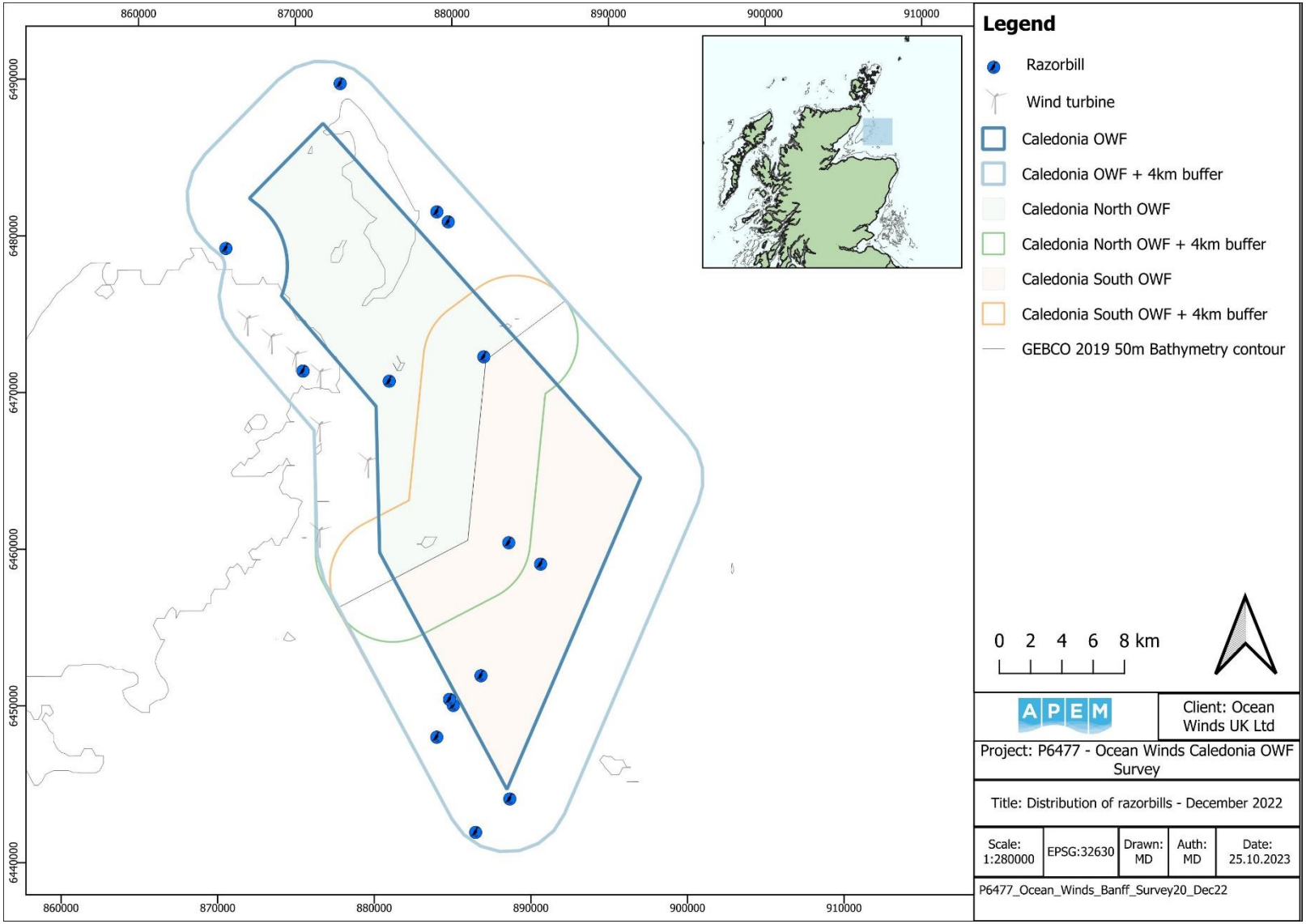



**Figure A4.187 Distribution of razorbills recorded in the Survey Area in December 2022**

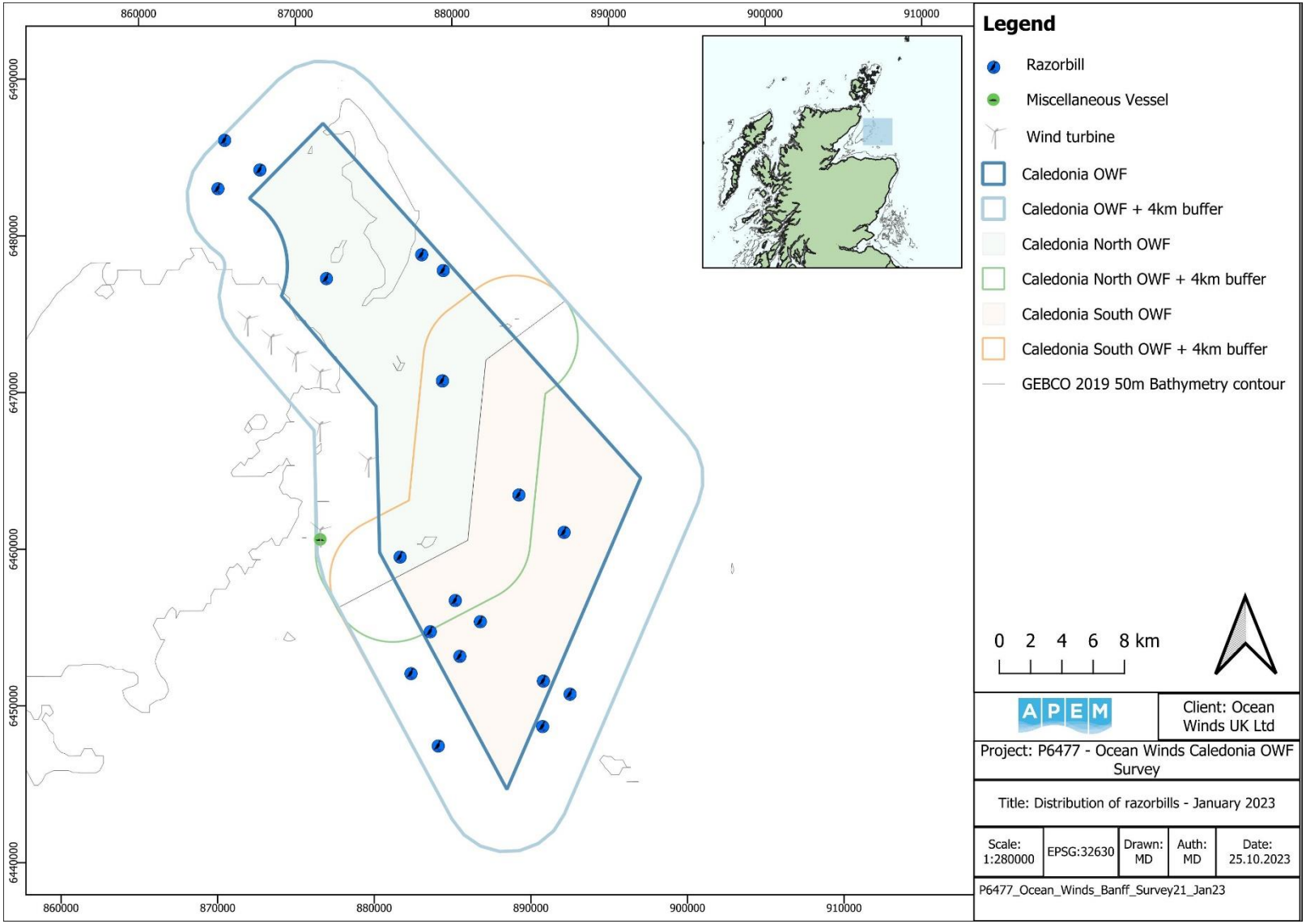



**Figure A4.188 Distribution of razorbills recorded in the Survey Area in January 2023**

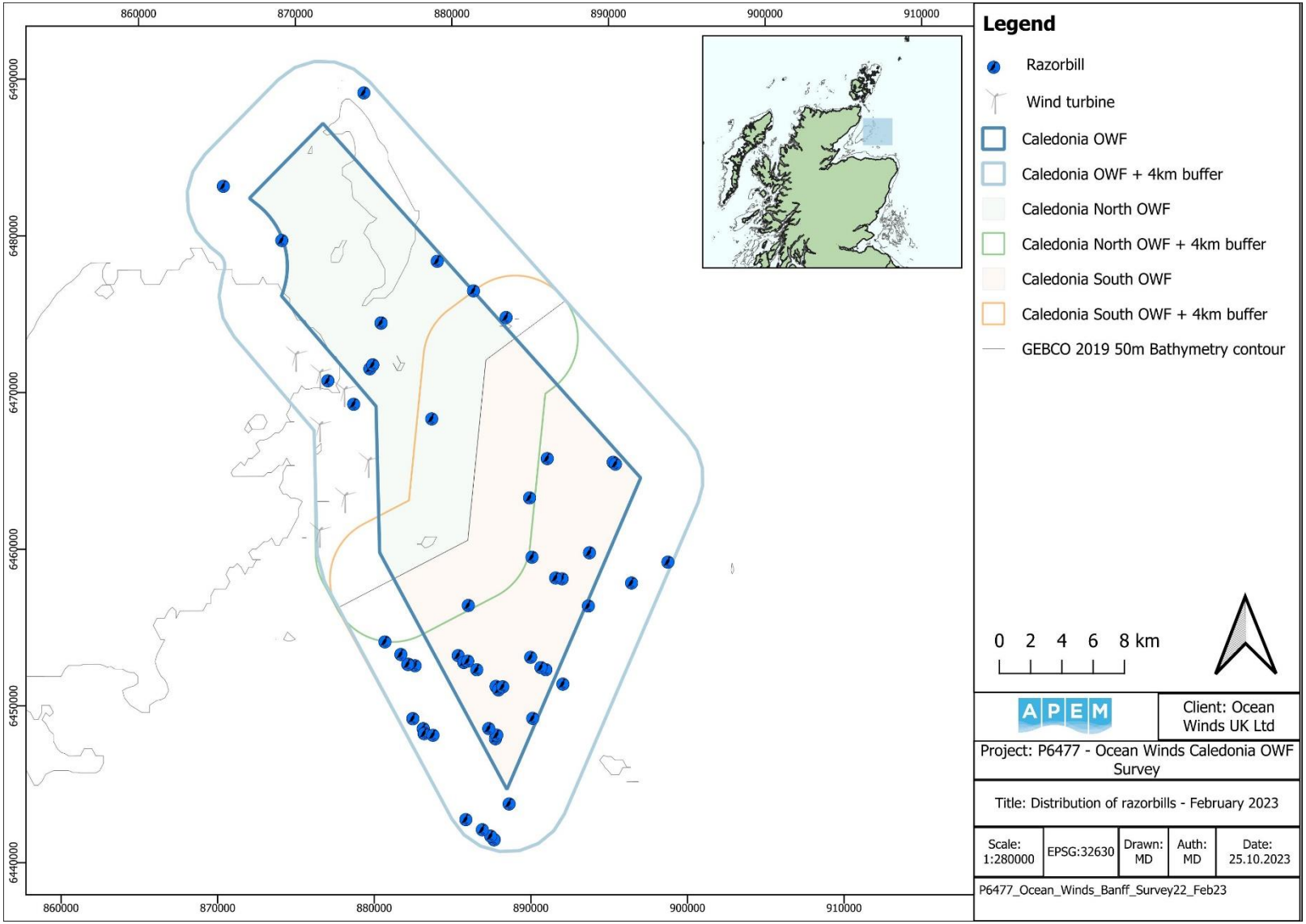



**Figure A4.189 Distribution of razorbills recorded in the Survey Area in February 2023**

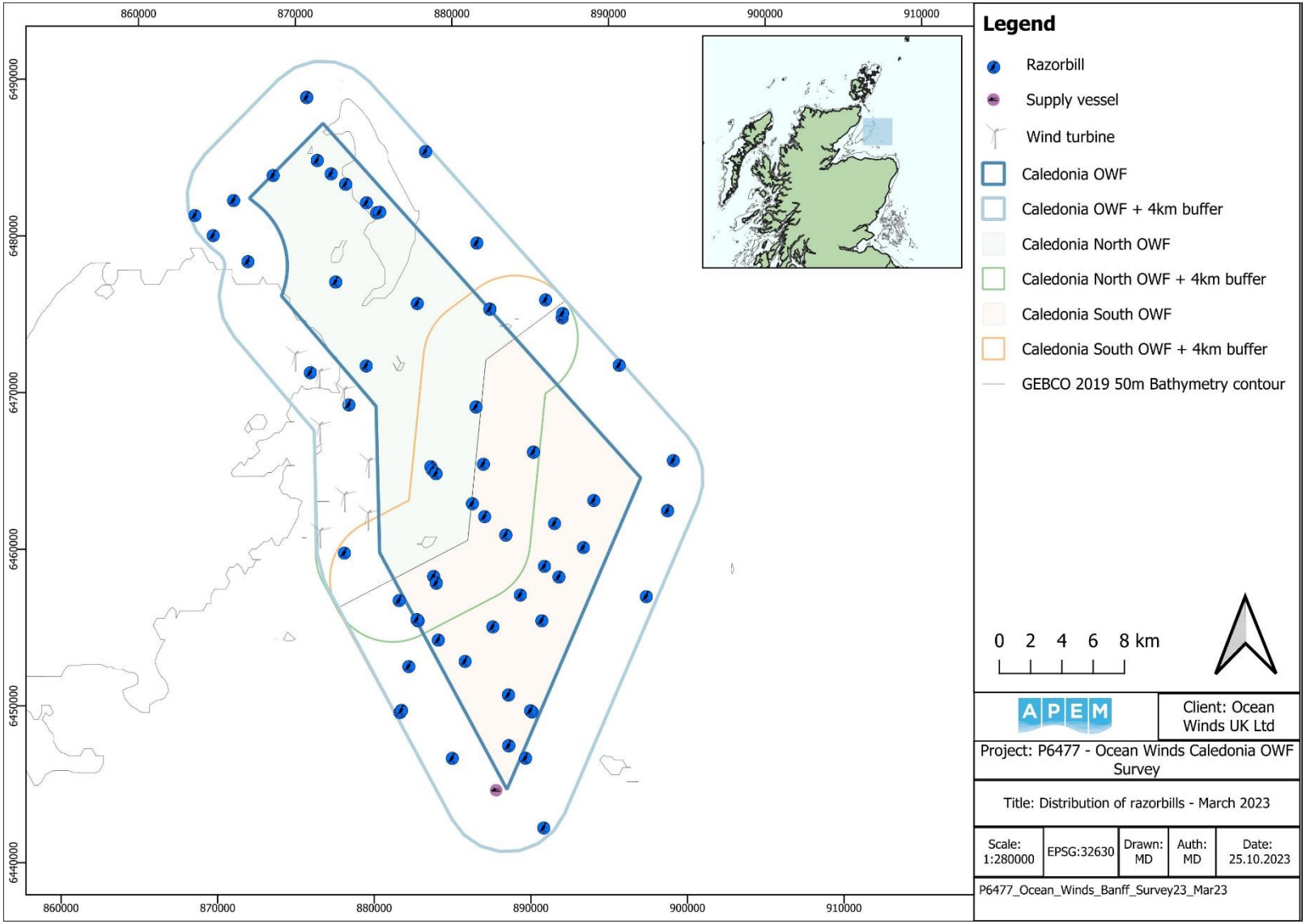



**Figure A4.190 Distribution of razorbills recorded in the Survey Area in March 2023**

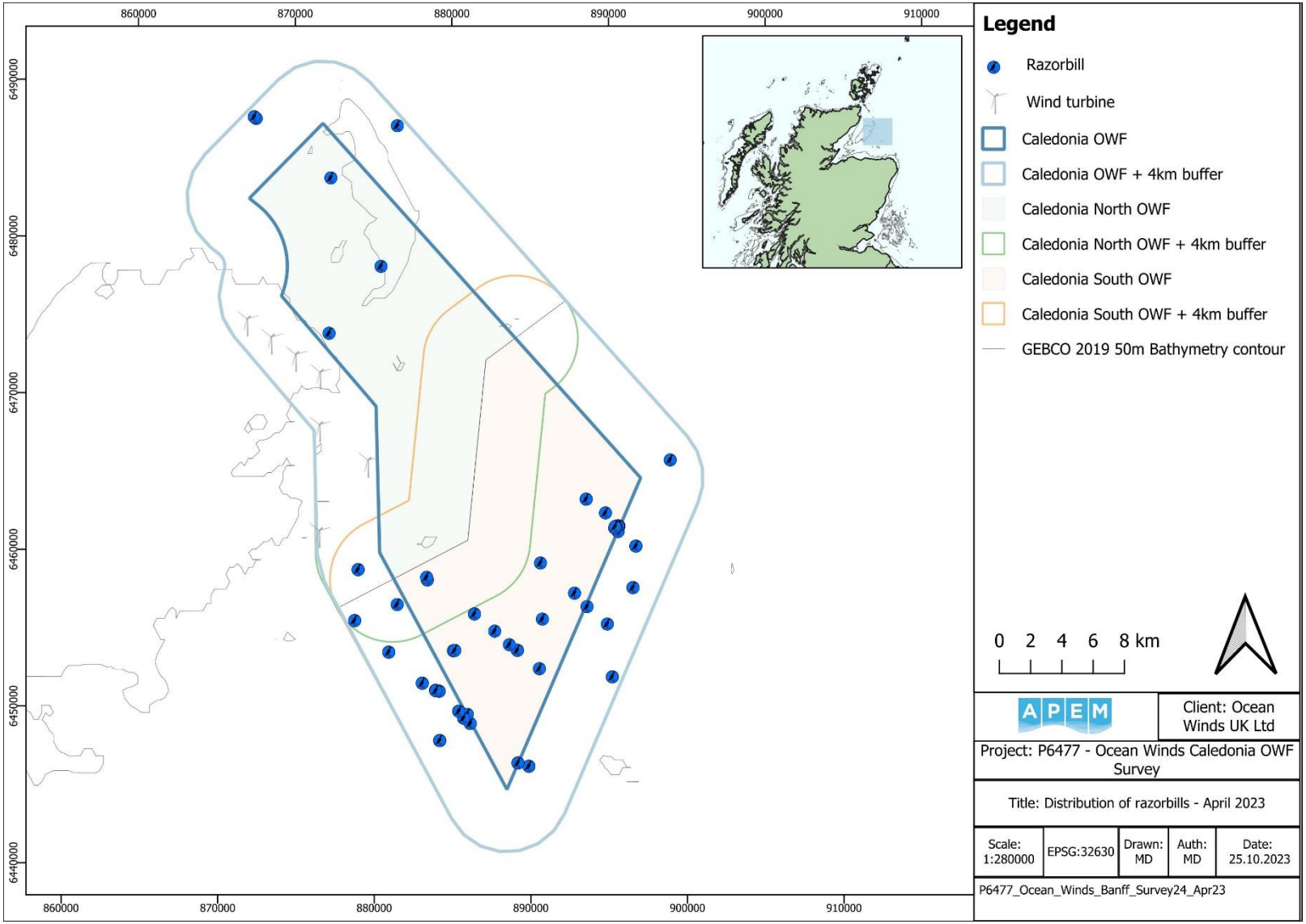



**Figure A4.191 Distribution of razorbills recorded in the Survey Area in April 2023**

## Guillemot and / or razorbills

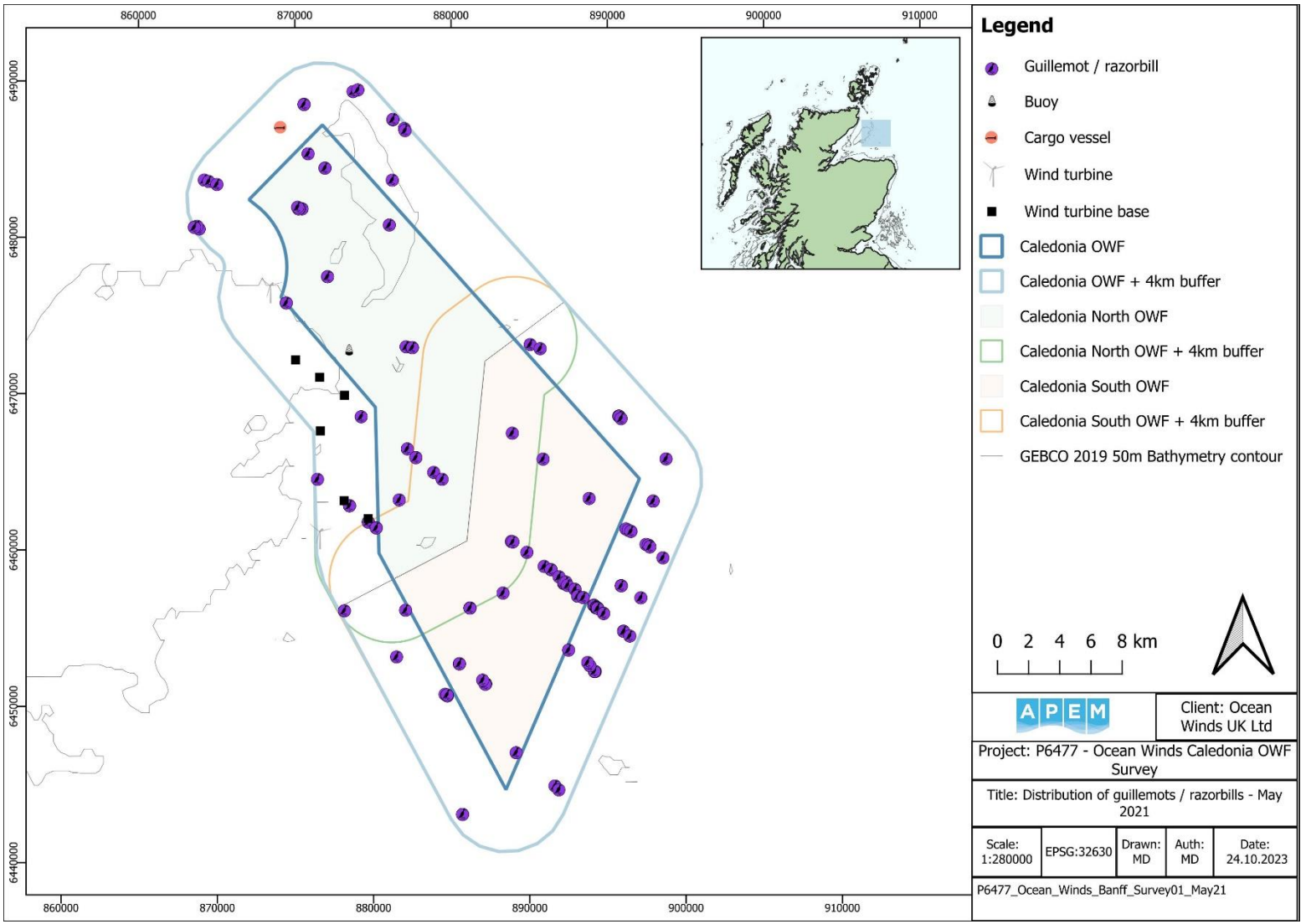



**Figure A4.192 Distribution of guillemots / razorbills recorded in the Survey Area in May 2021**

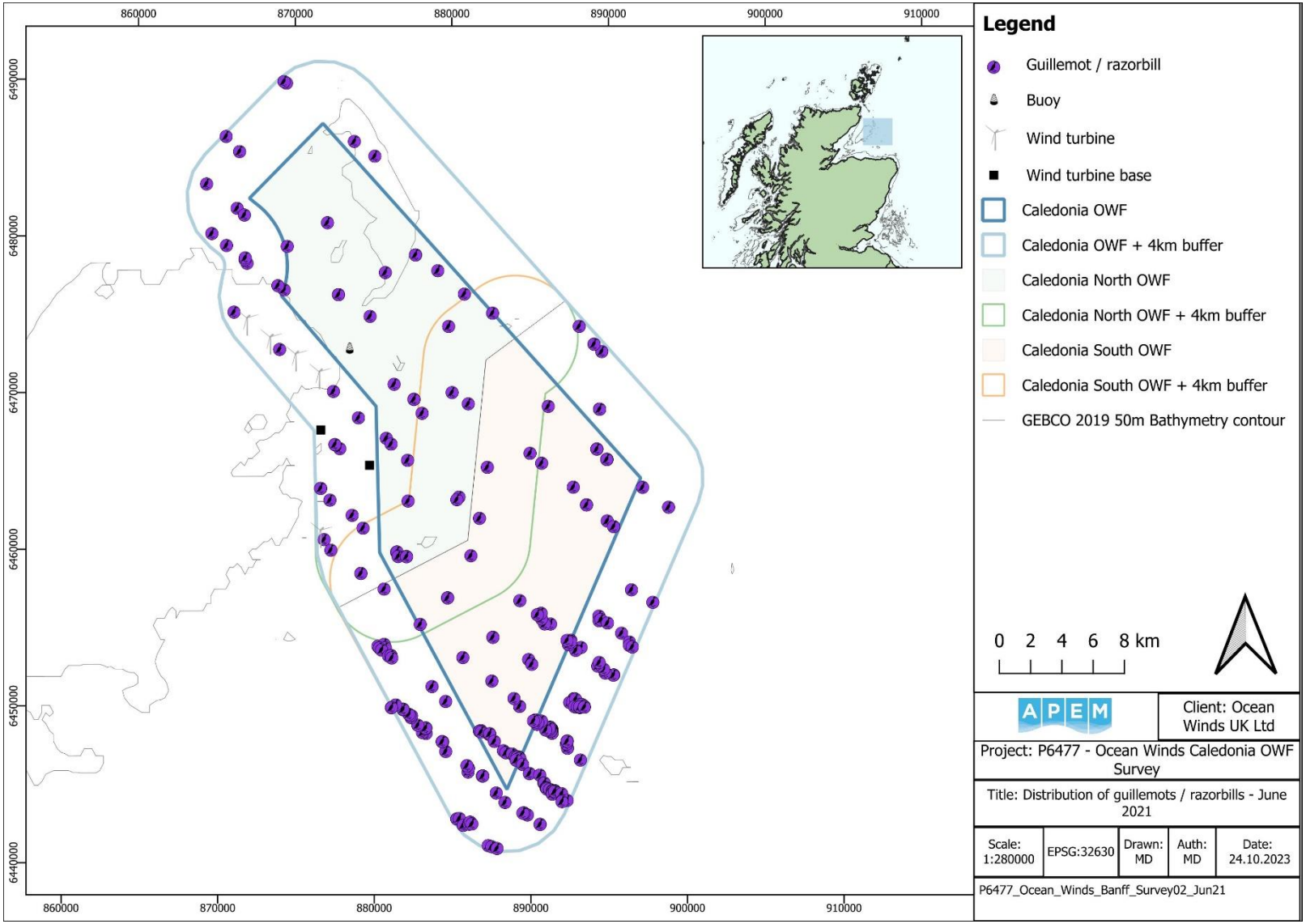



**Figure A4.193 Distribution of guillemots / razorbills recorded in the Survey Area in June 2021**

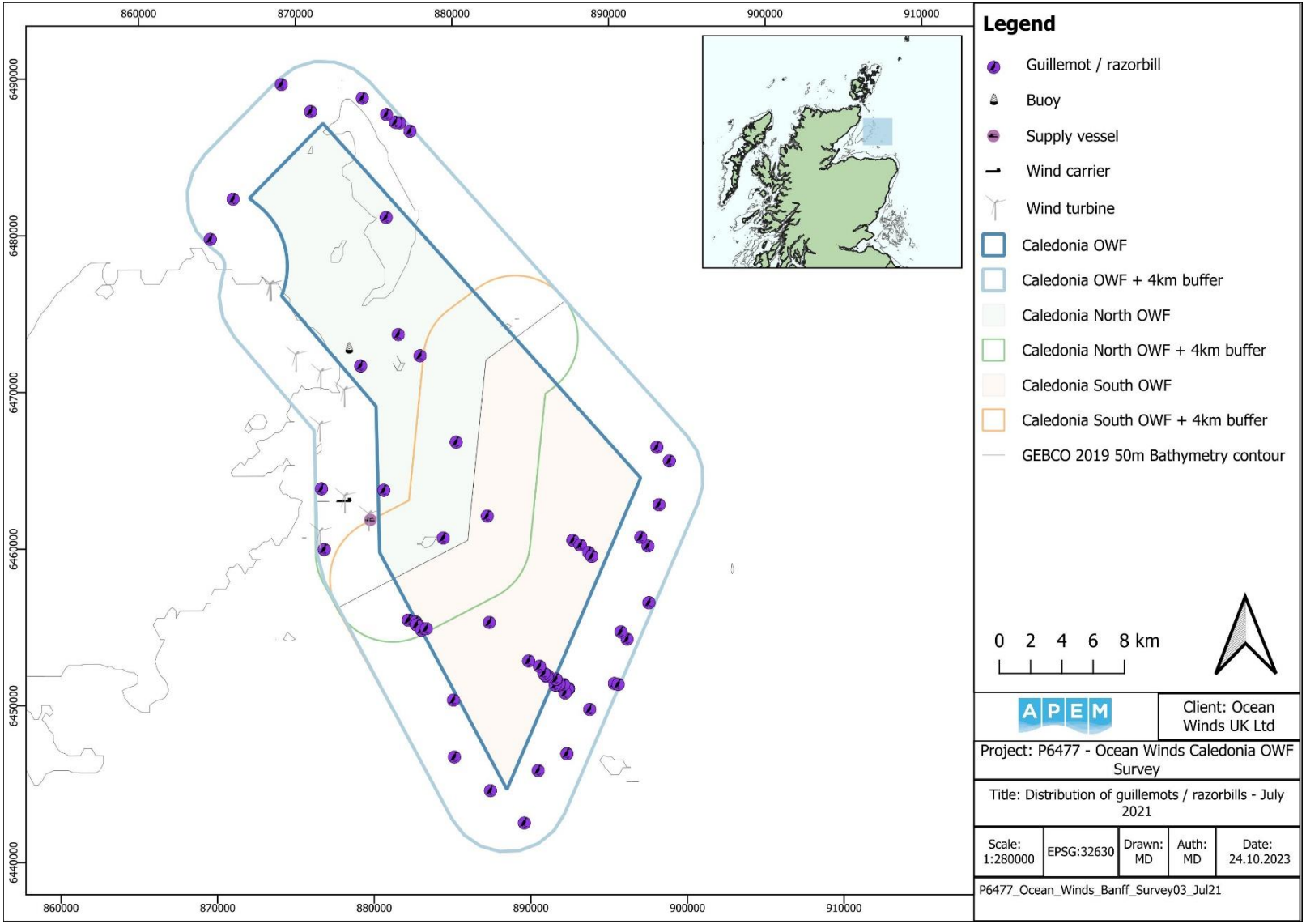



**Figure A4.194 Distribution of guillemots / razorbills recorded in the Survey Area in July 2021**

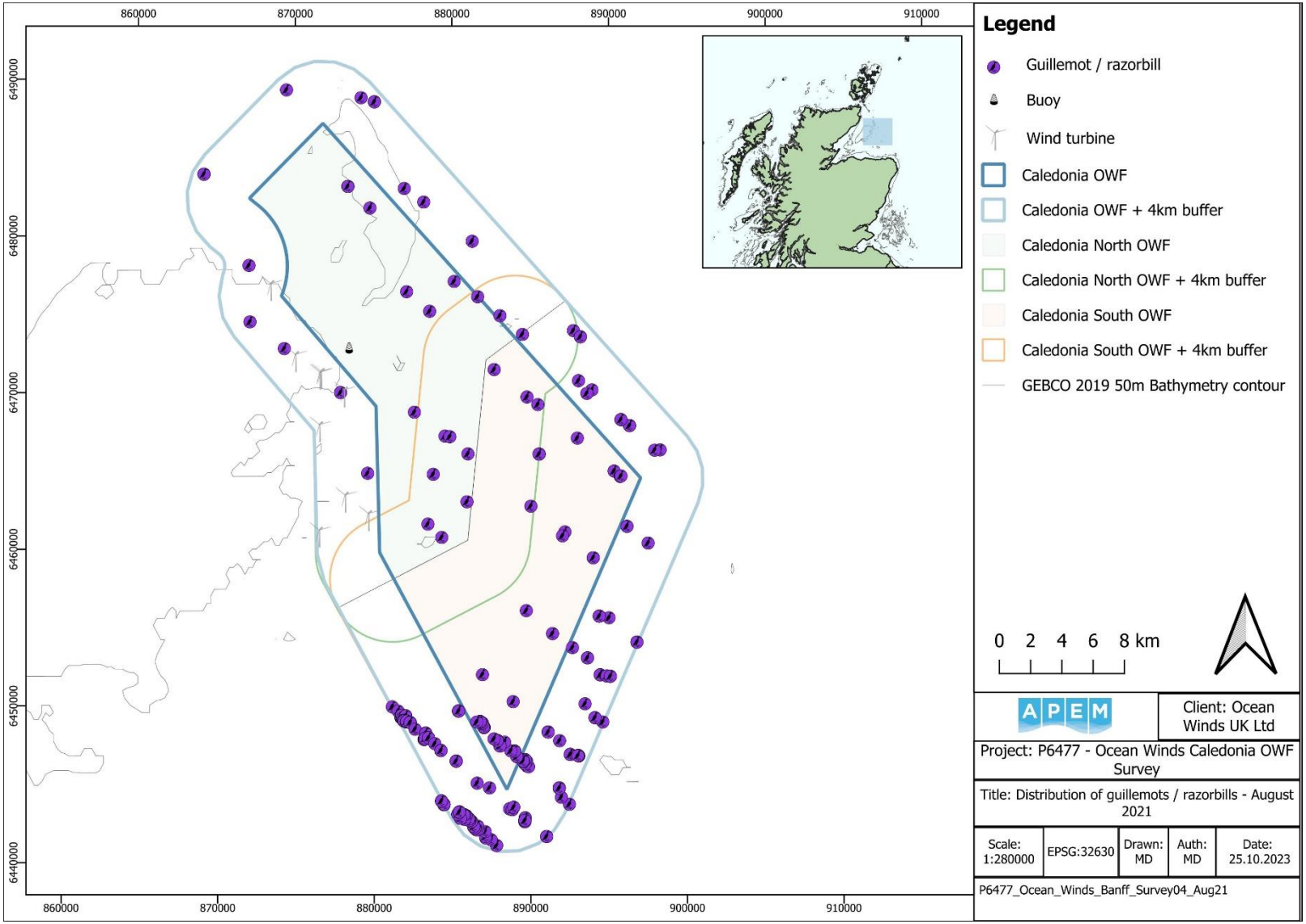



**Figure A4.195 Distribution of guillemots / razorbills recorded in the Survey Area in August 2021**

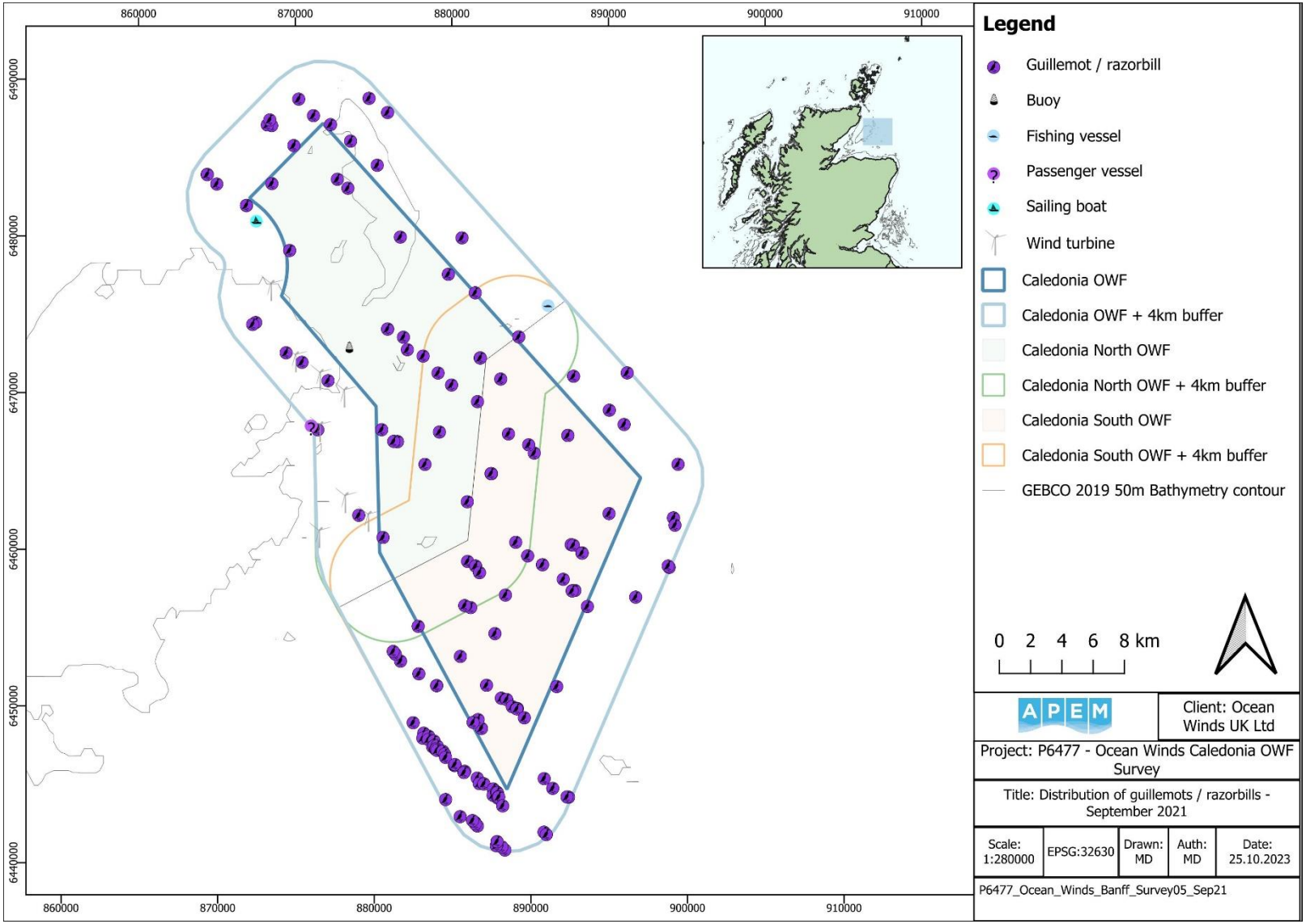



**Figure A4.196 Distribution of guillemots / razorbills recorded in the Survey Area in September 2021**

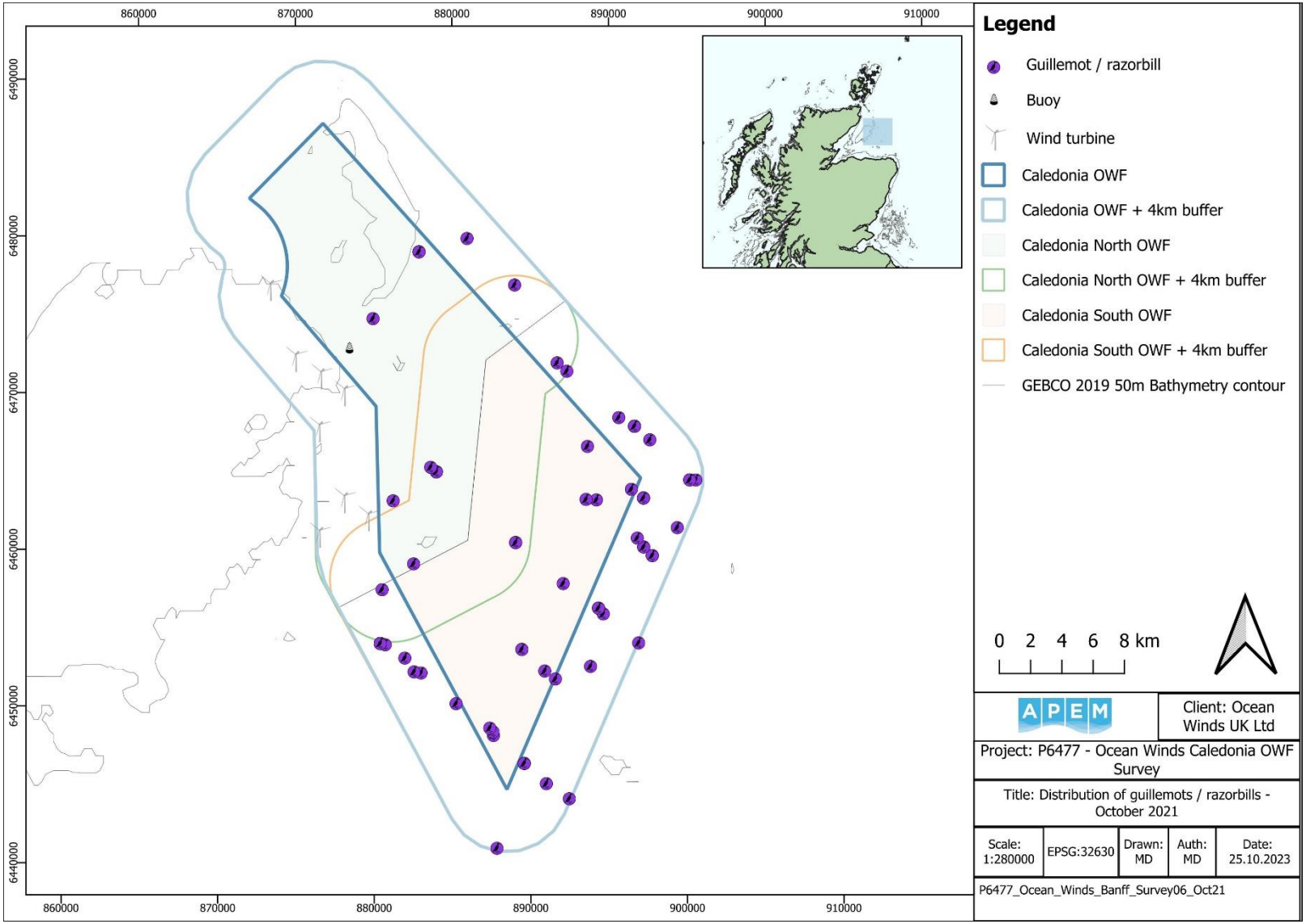



**Figure A4.197 Distribution of guillemots / razorbills recorded in the Survey Area in October 2021**

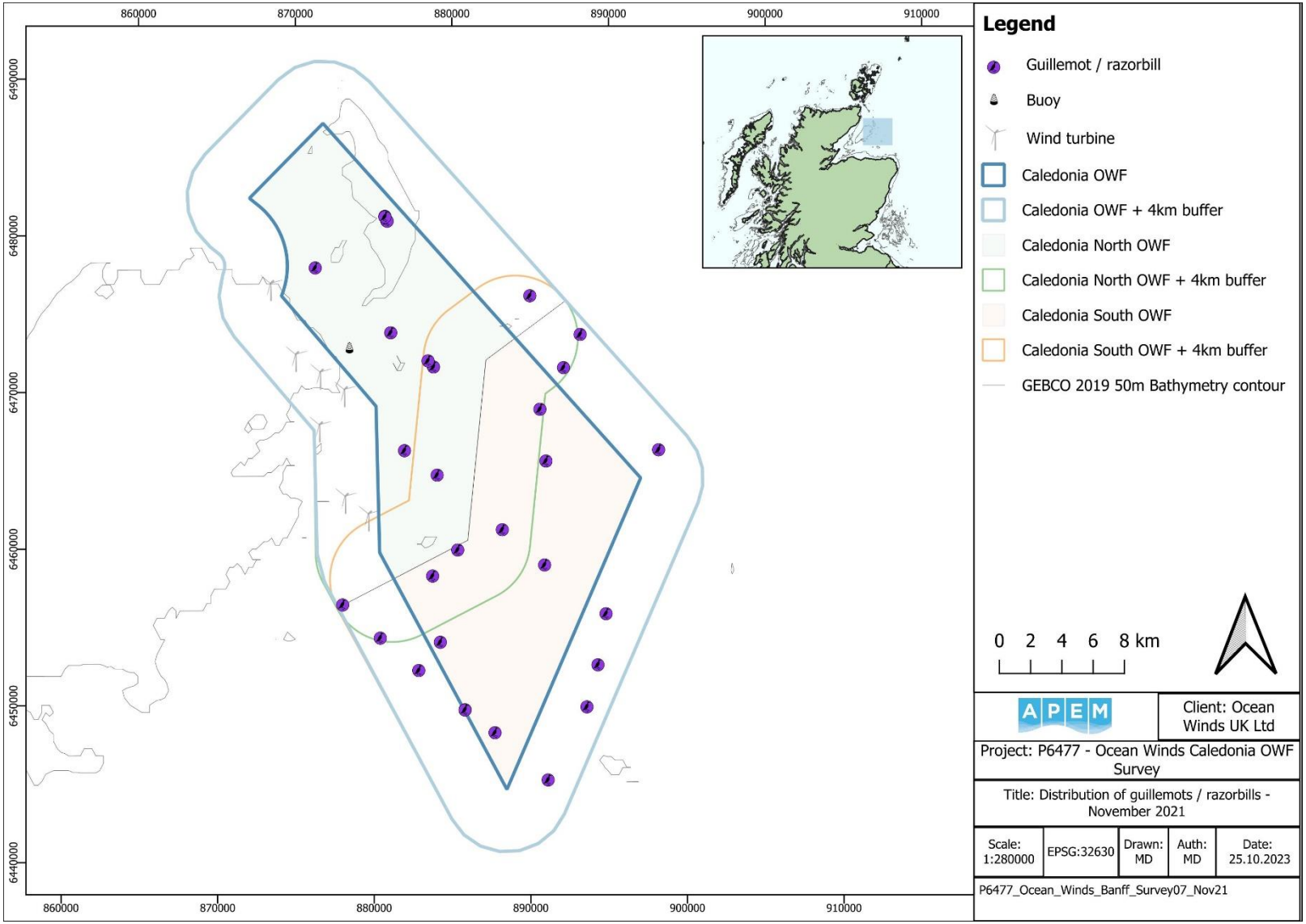



**Figure A4.198 Distribution of guillemots / razorbills recorded in the Survey Area in November 2021**

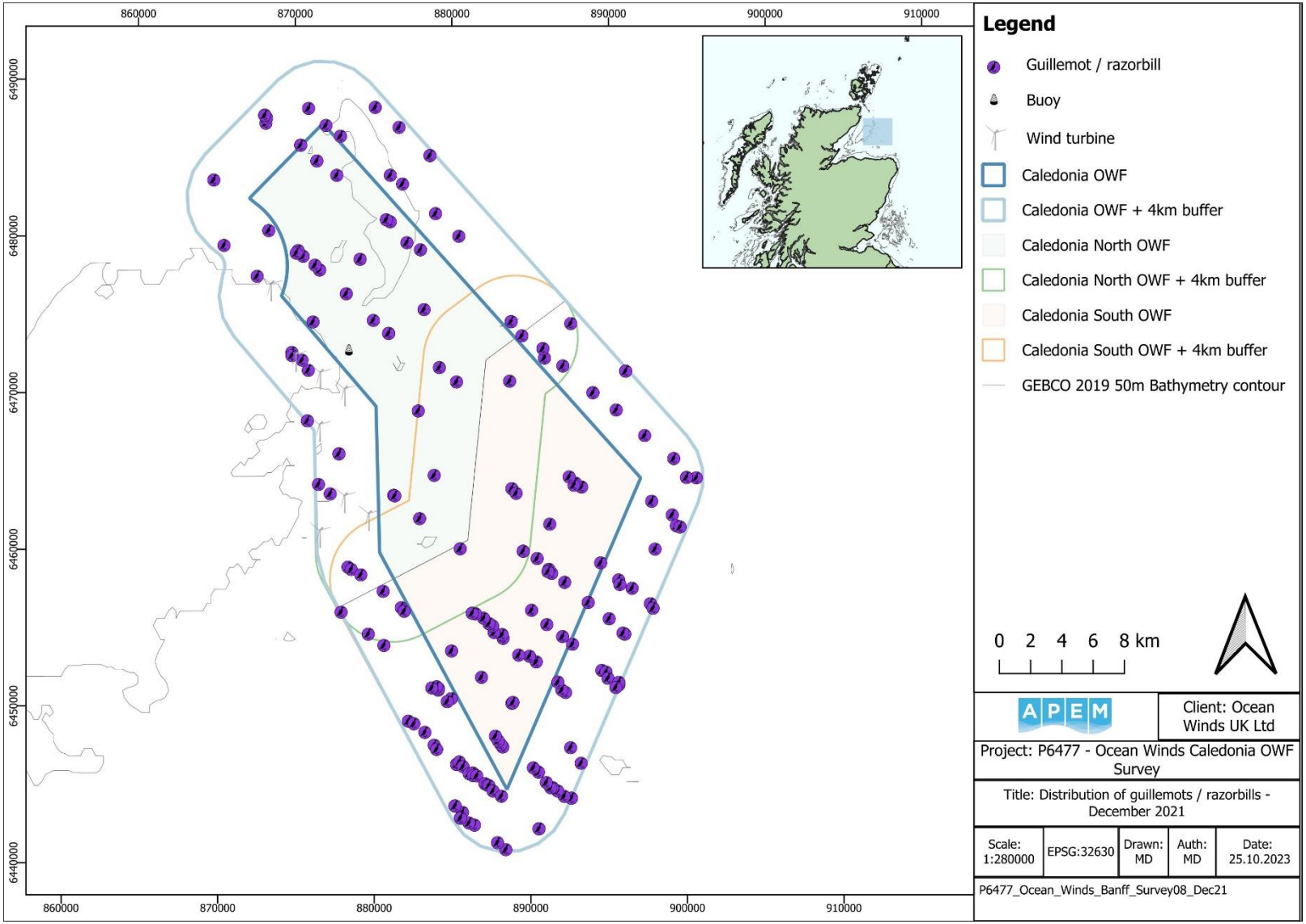



**Figure A4.199 Distribution of guillemots / razorbills recorded in the Survey Area in December 2021**

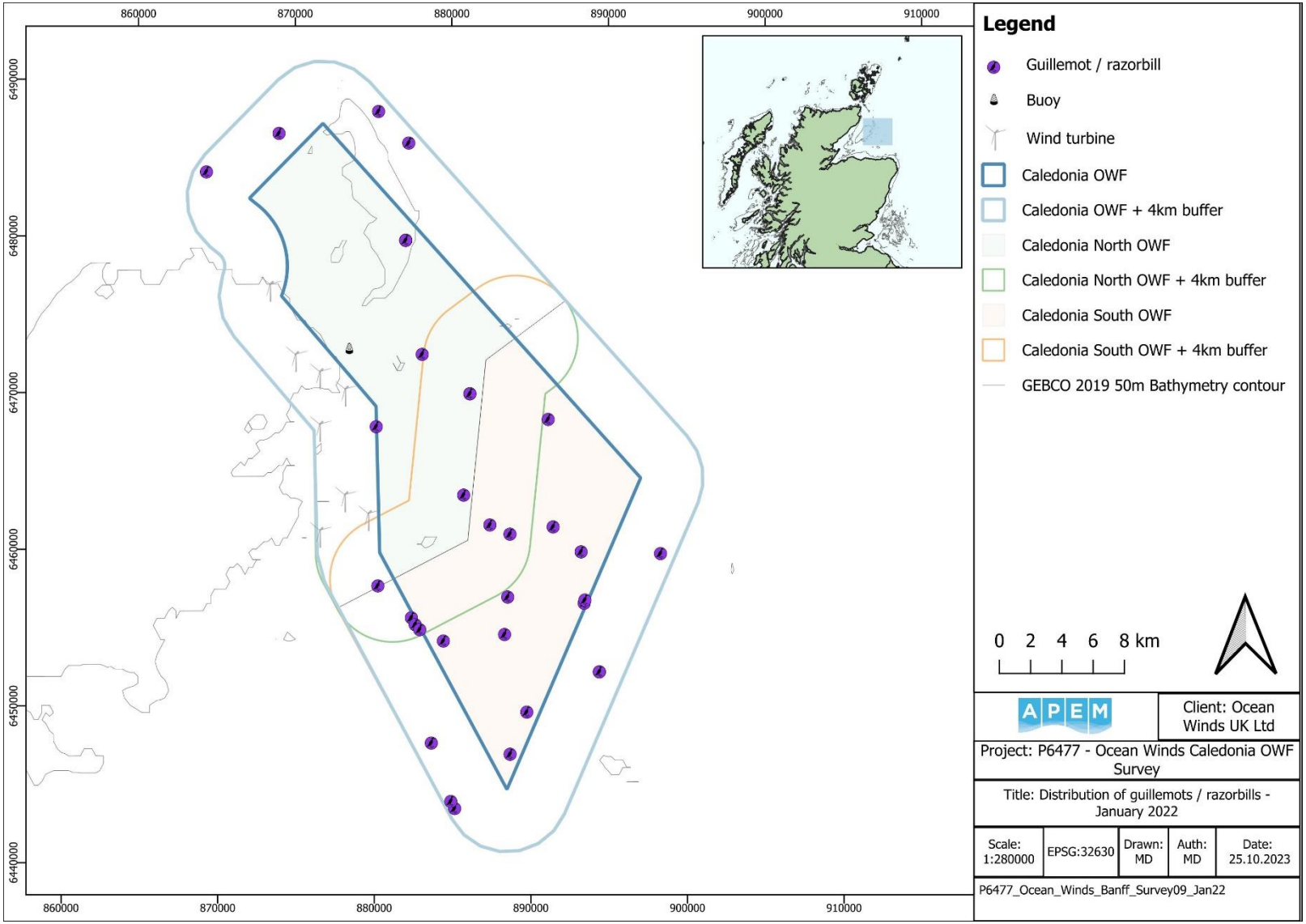



**Figure A4.200 Distribution of guillemots / razorbills recorded in the Survey Area in January 2022**

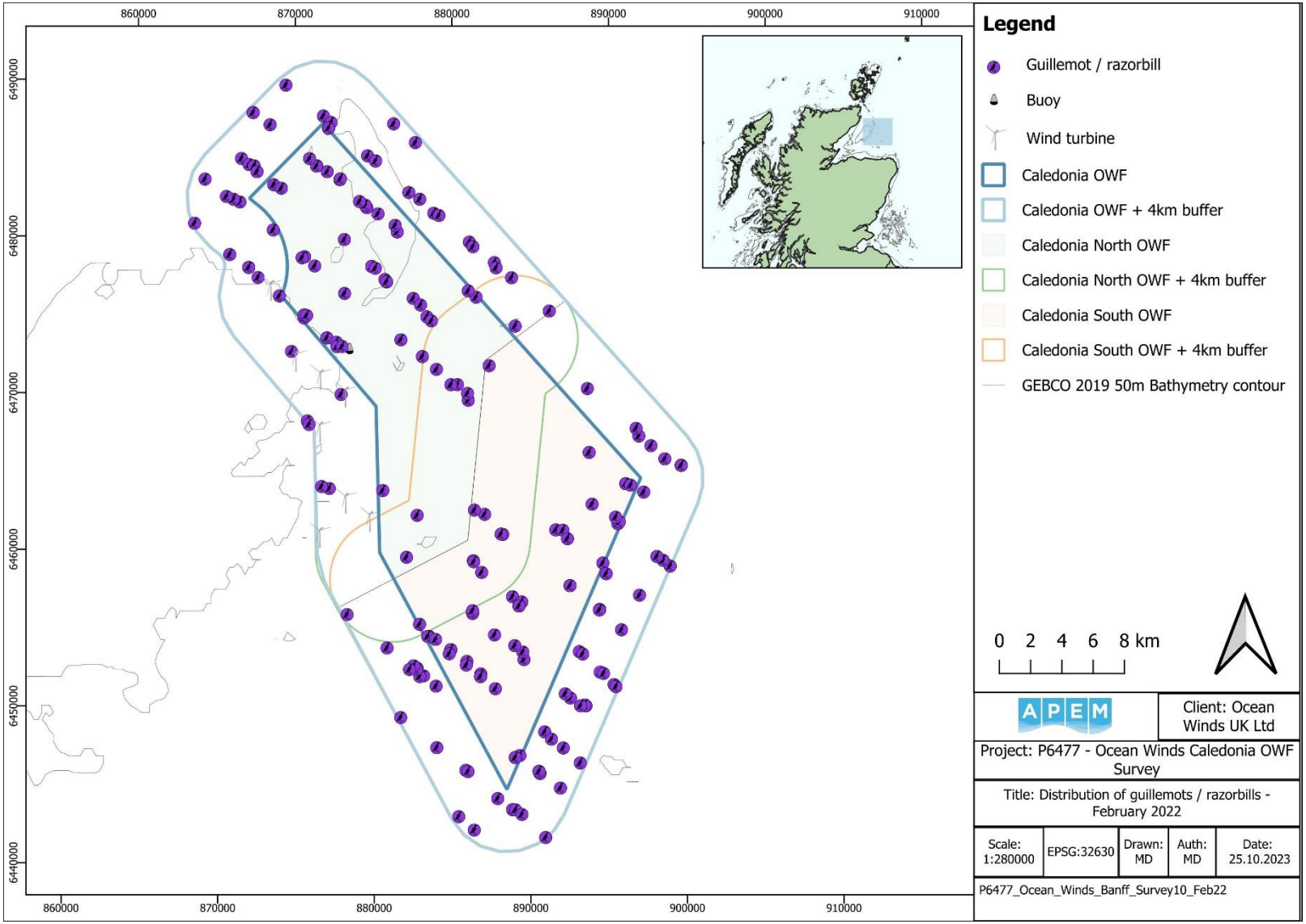



**Figure A4.201 Distribution of guillemots / razorbills recorded in the Survey Area in February 2022**

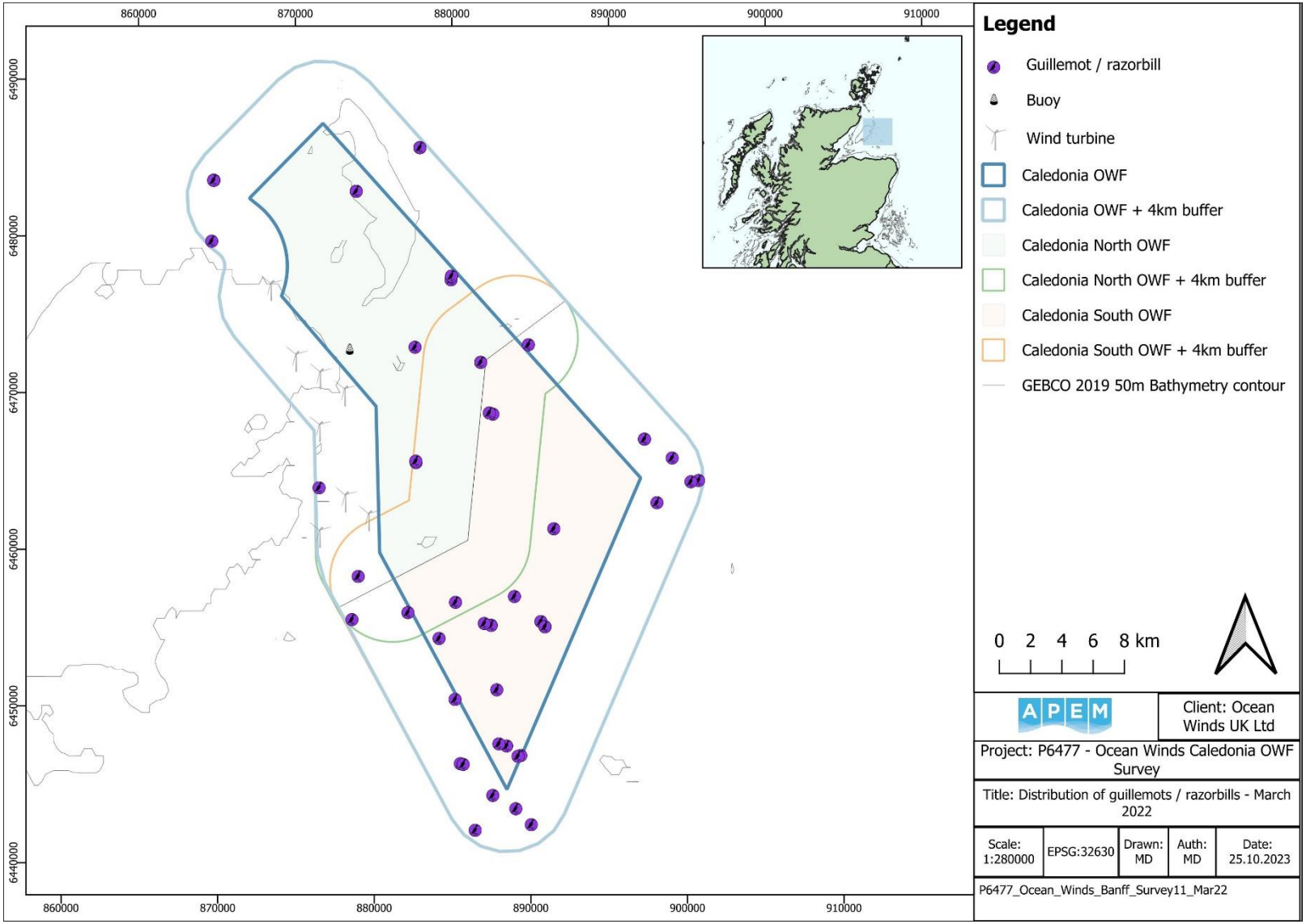



**Figure A4.202 Distribution of guillemots / razorbills recorded in the Survey Area in March 2022**

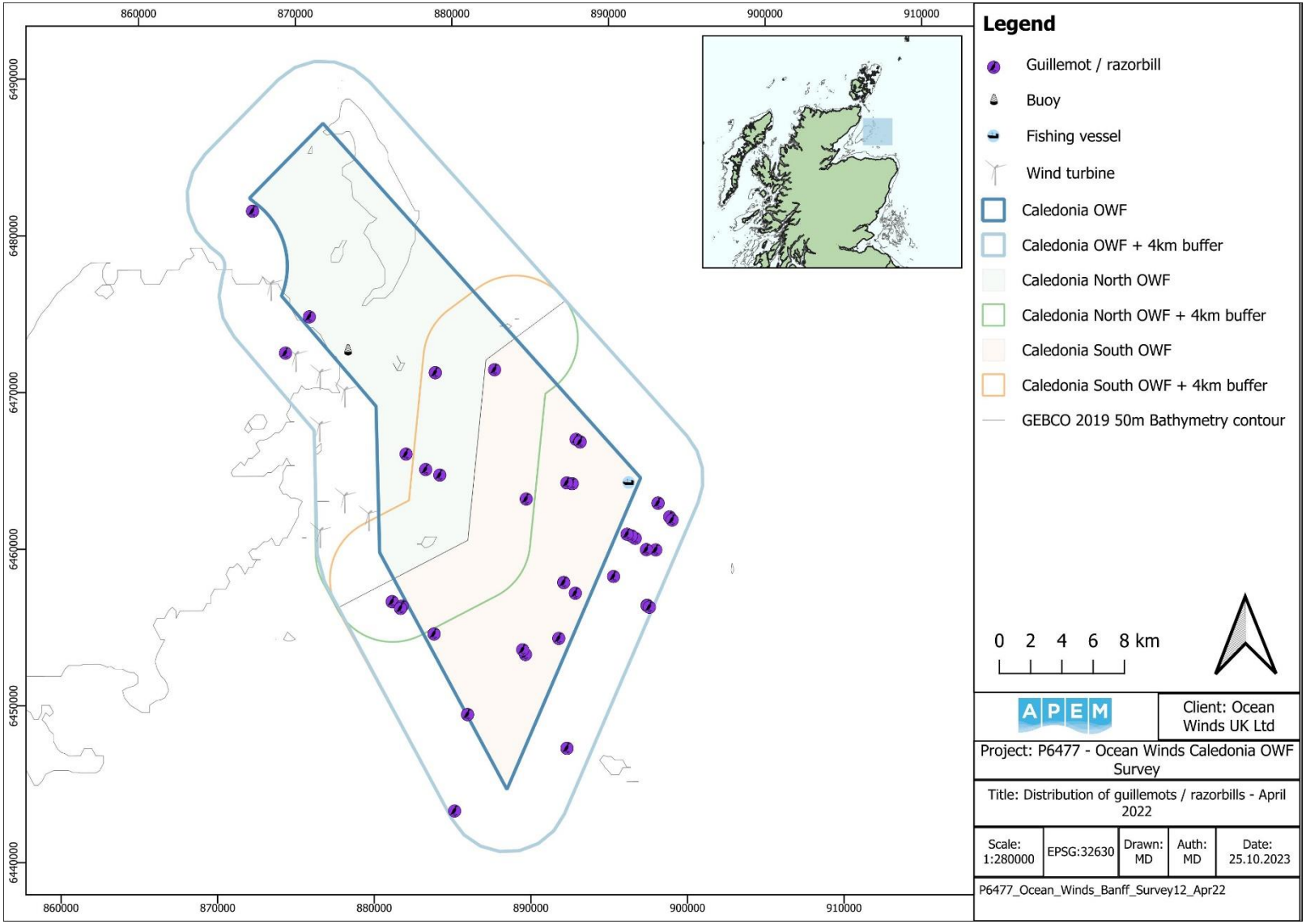



**Figure A4.203 Distribution of guillemots / razorbills recorded in the Survey Area in April 2022**

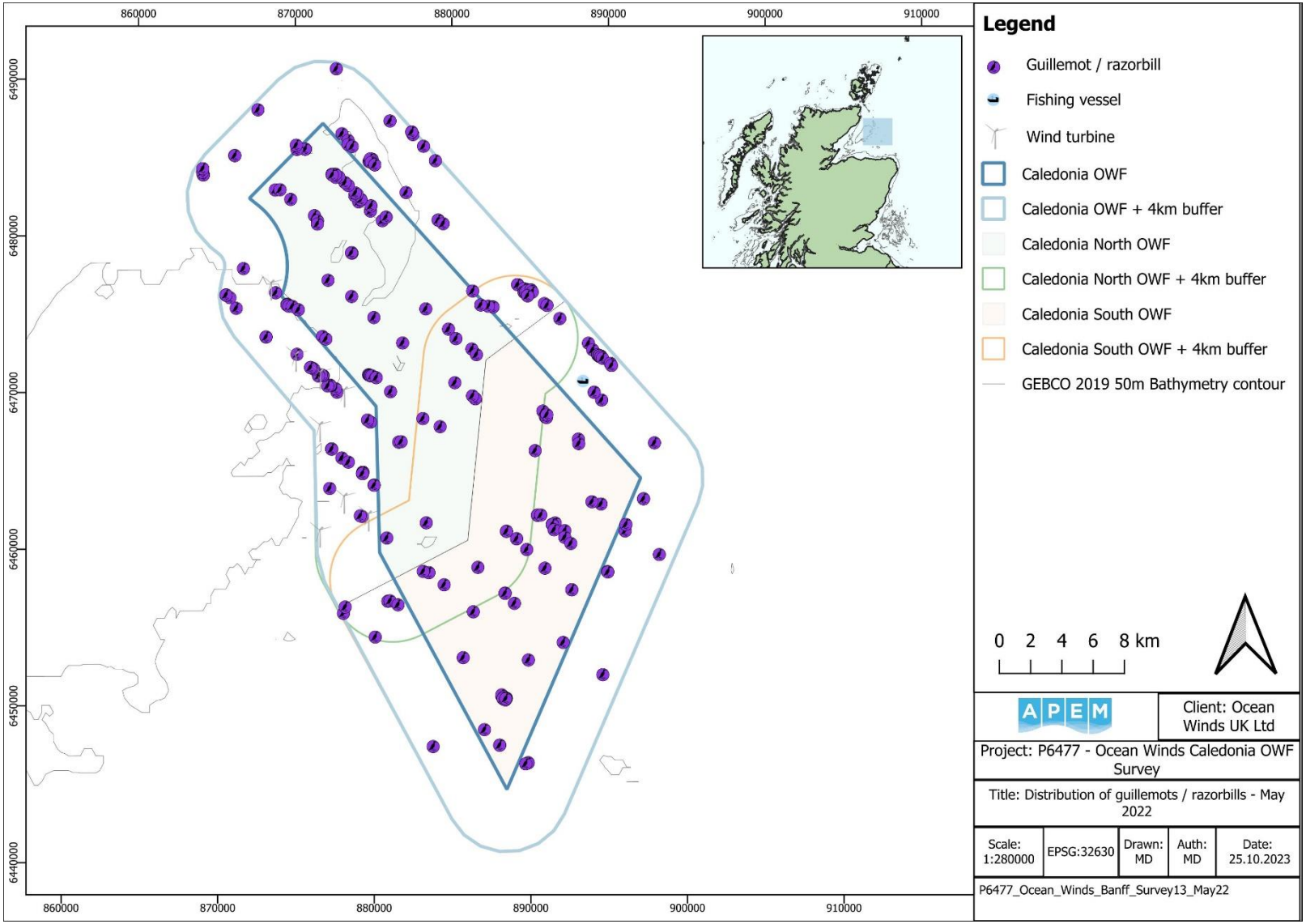



**Figure A4.204 Distribution of guillemots / razorbills recorded in the Survey Area in May 2022**

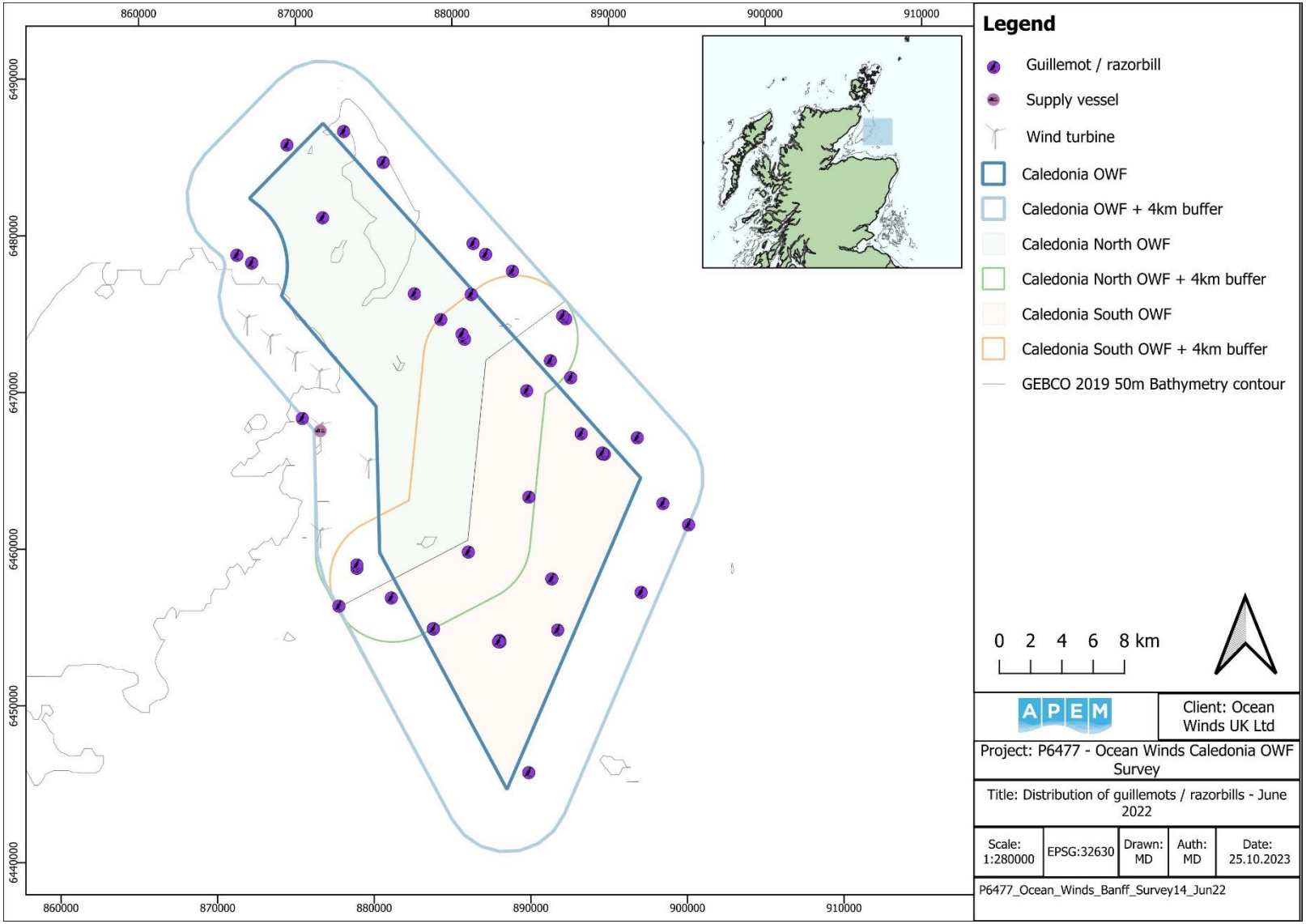



**Figure A4.205 Distribution of guillemots / razorbills recorded in the Survey Area in June 2022**

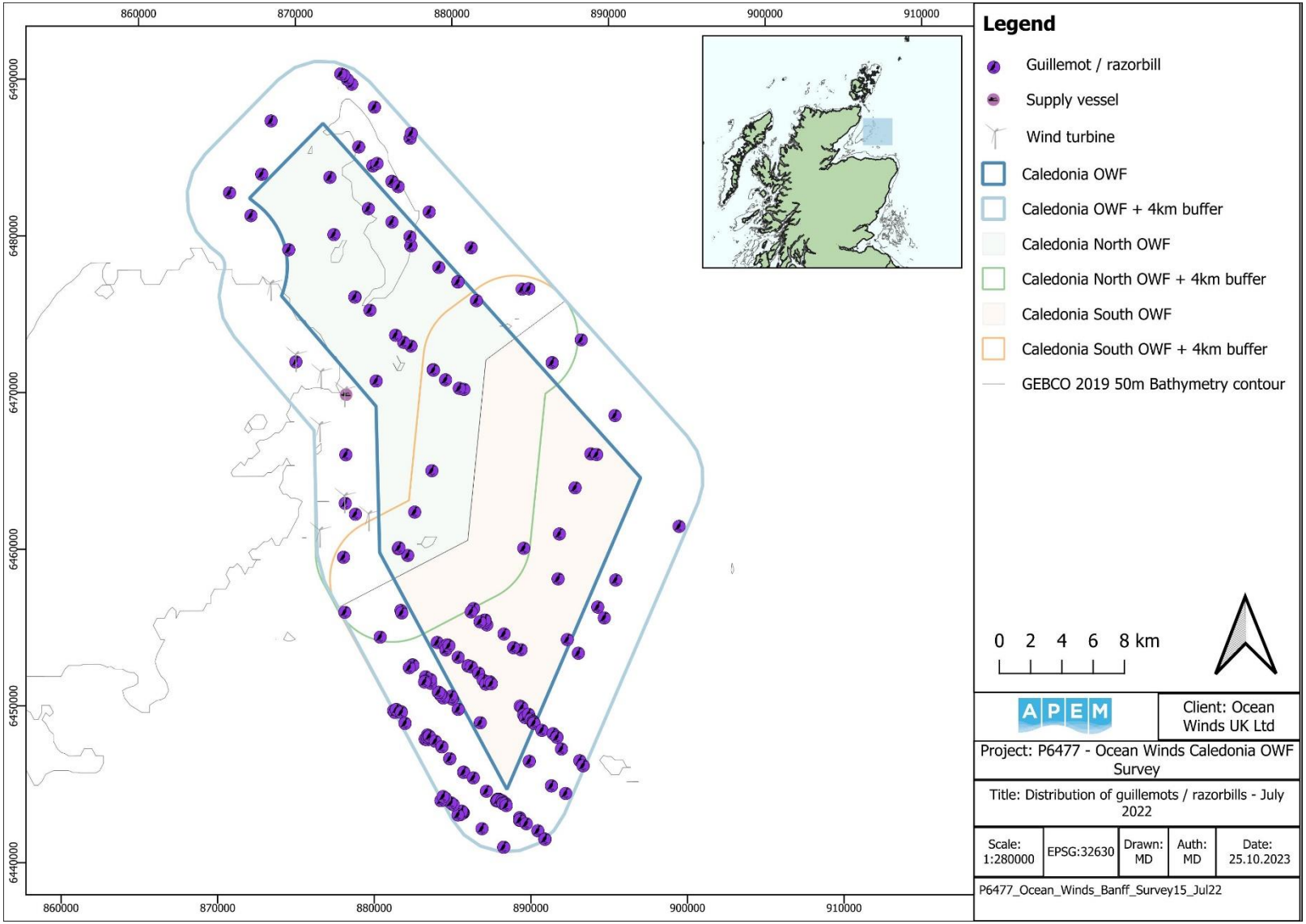



**Figure A4.206 Distribution of guillemots / razorbills recorded in the Survey Area in July 2022**

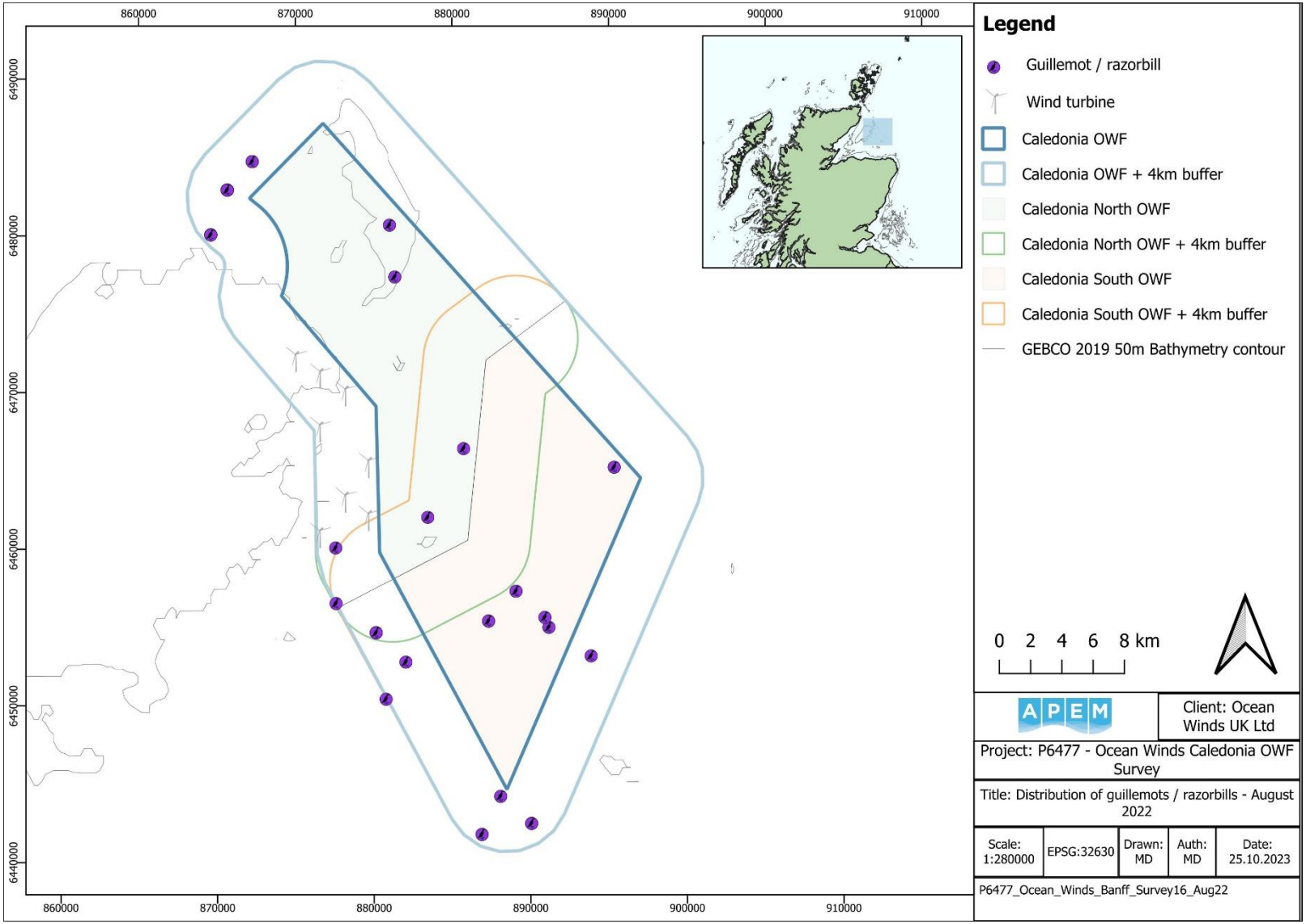



**Figure A4.207 Distribution of guillemots / razorbills recorded in the Survey Area in August 2022**

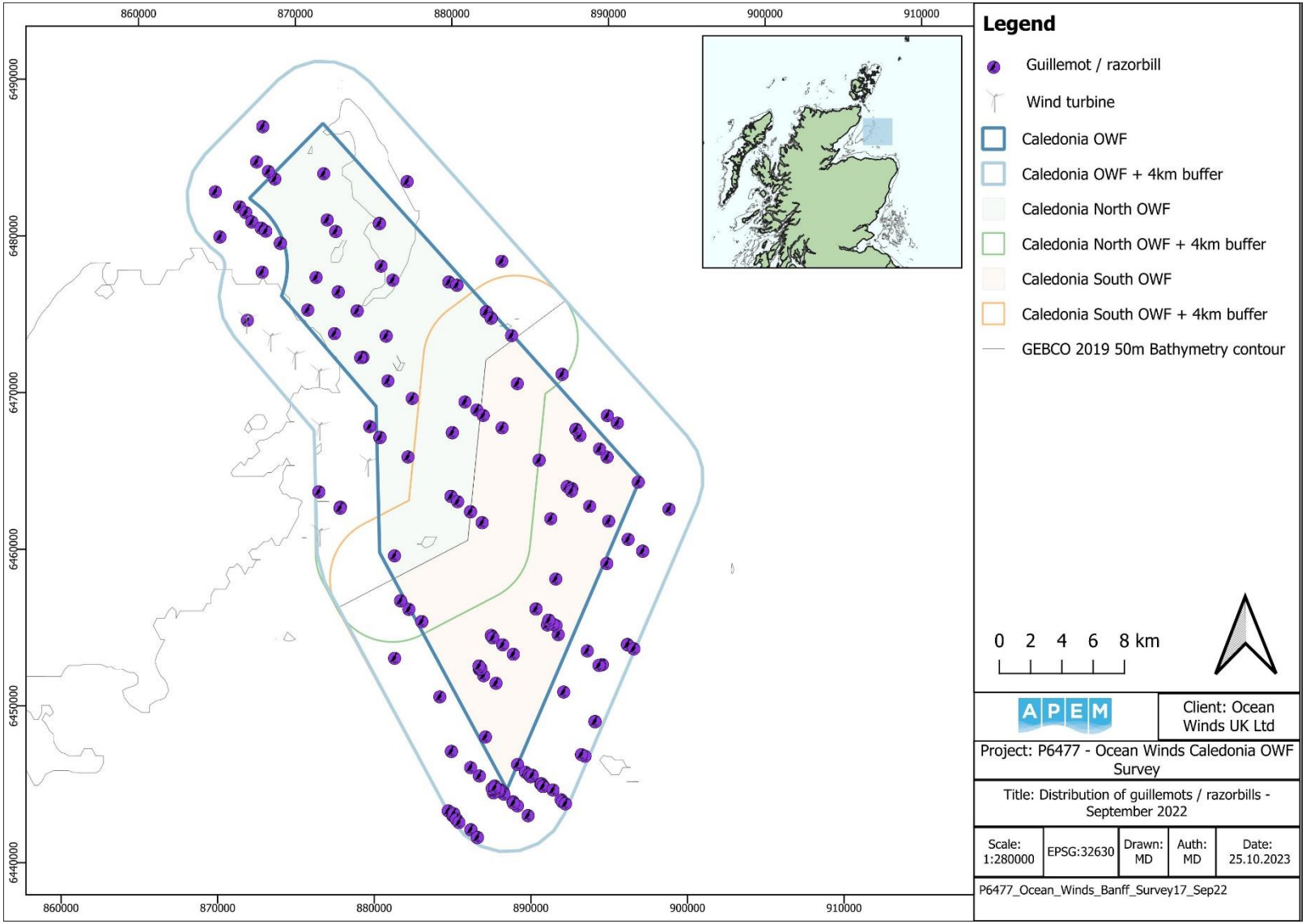



**Figure A4.208 Distribution of guillemots / razorbills recorded in the Survey Area in September 2022**

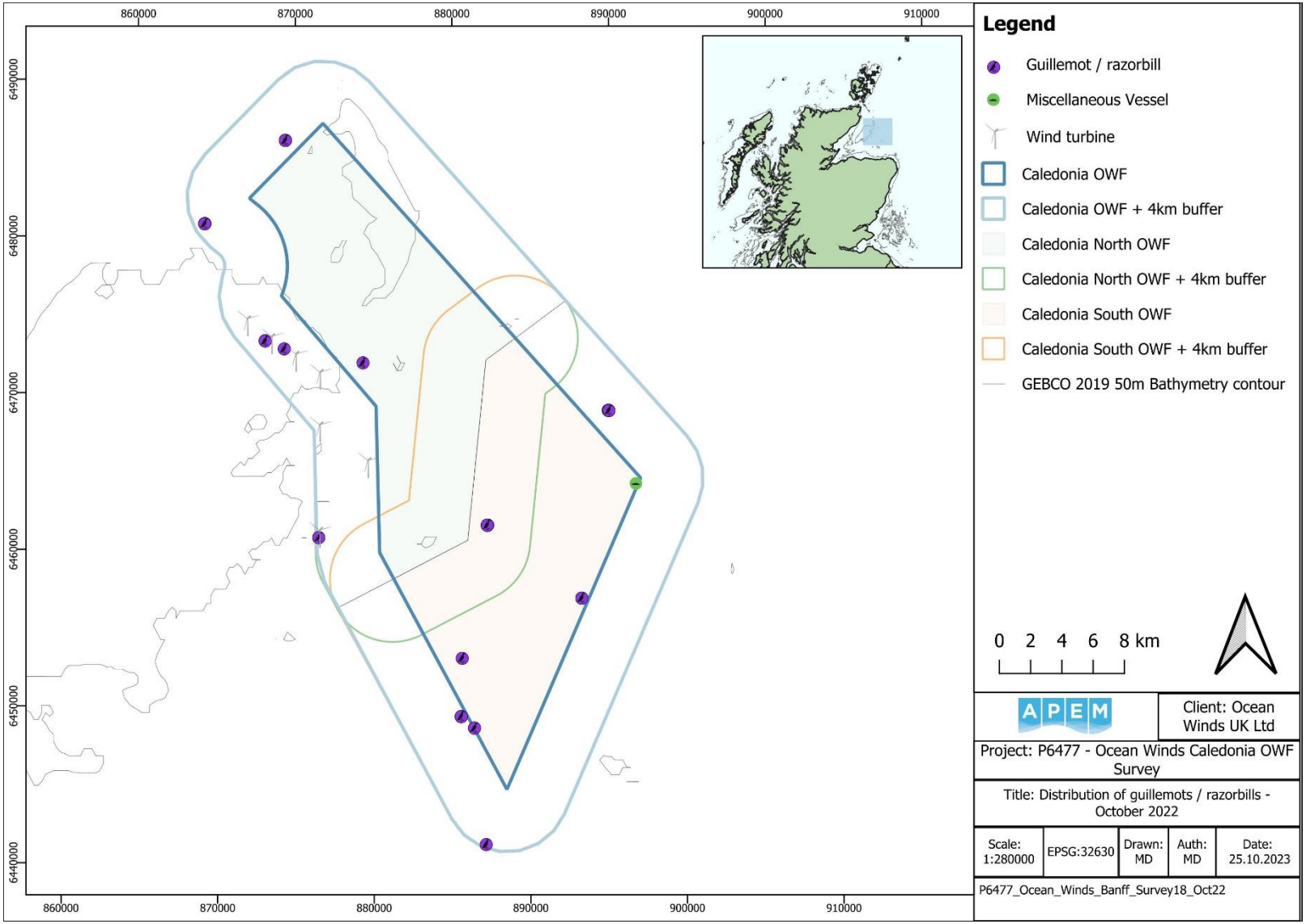



**Figure A4.209 Distribution of guillemots / razorbills recorded in the Survey Area in October 2022**

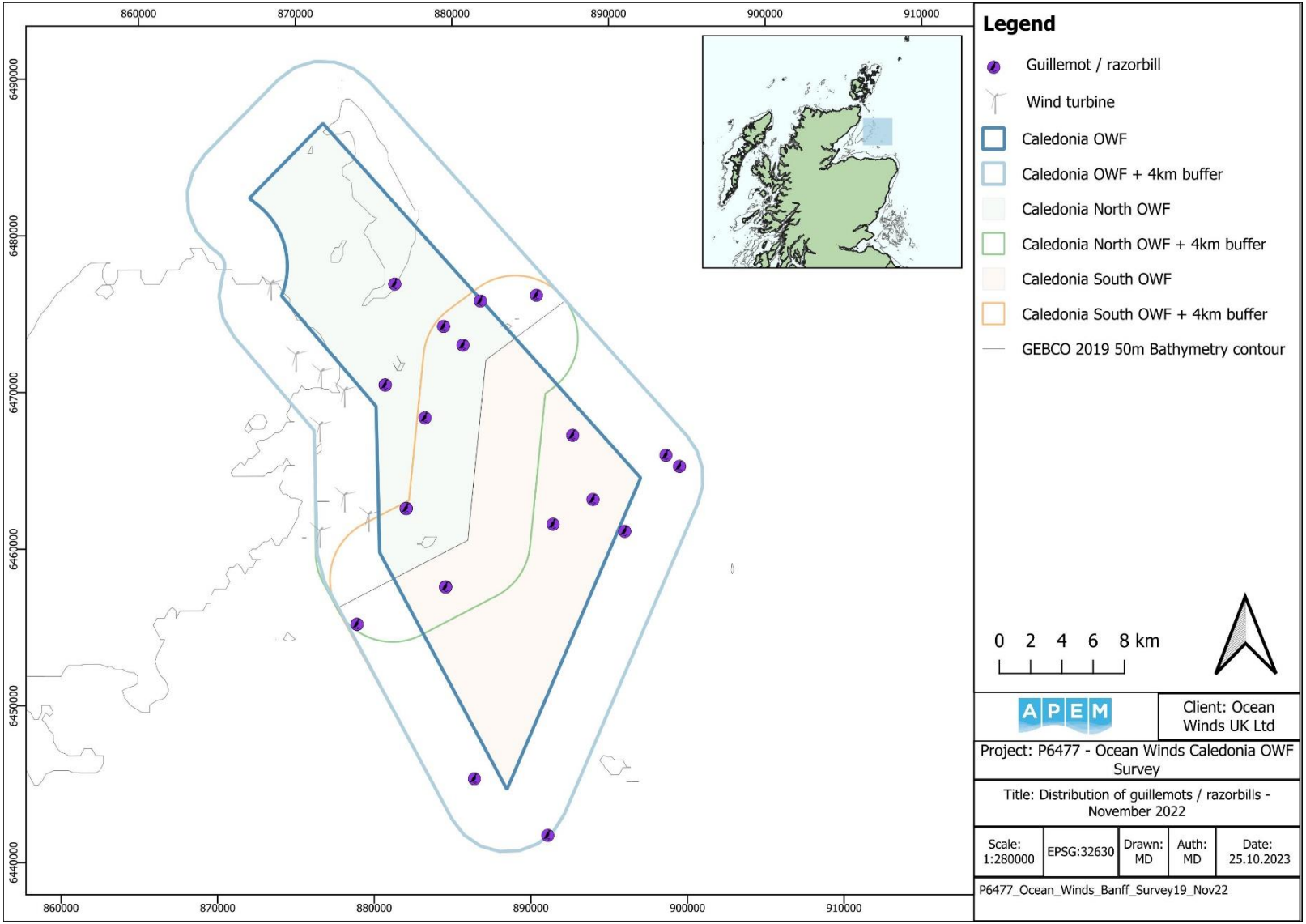



**Figure A4.210 Distribution of guillemots / razorbills recorded in the Survey Area in November 2022**

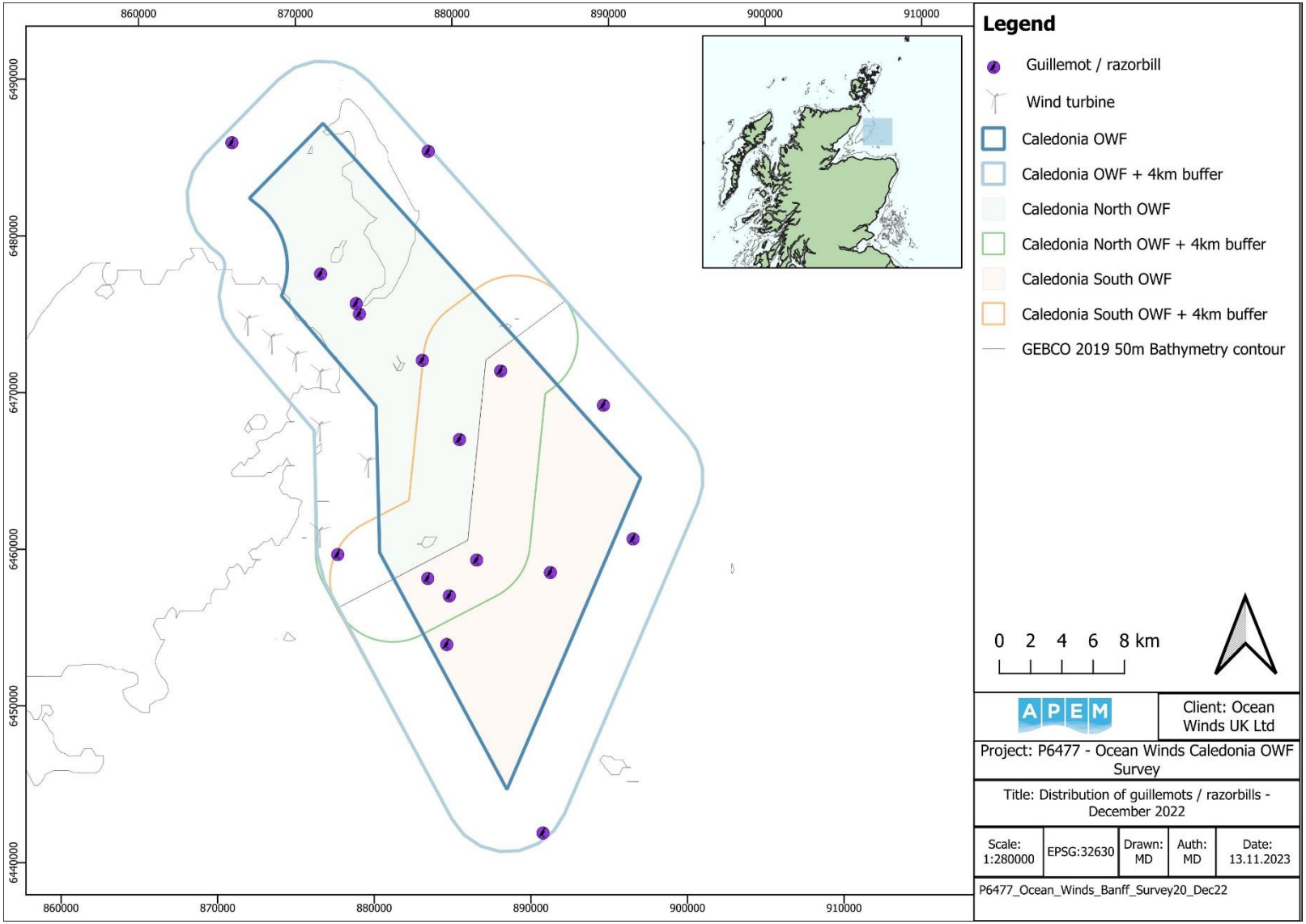



**Figure A4.211 Distribution of guillemots / razorbills recorded in the Survey Area in December 2022**

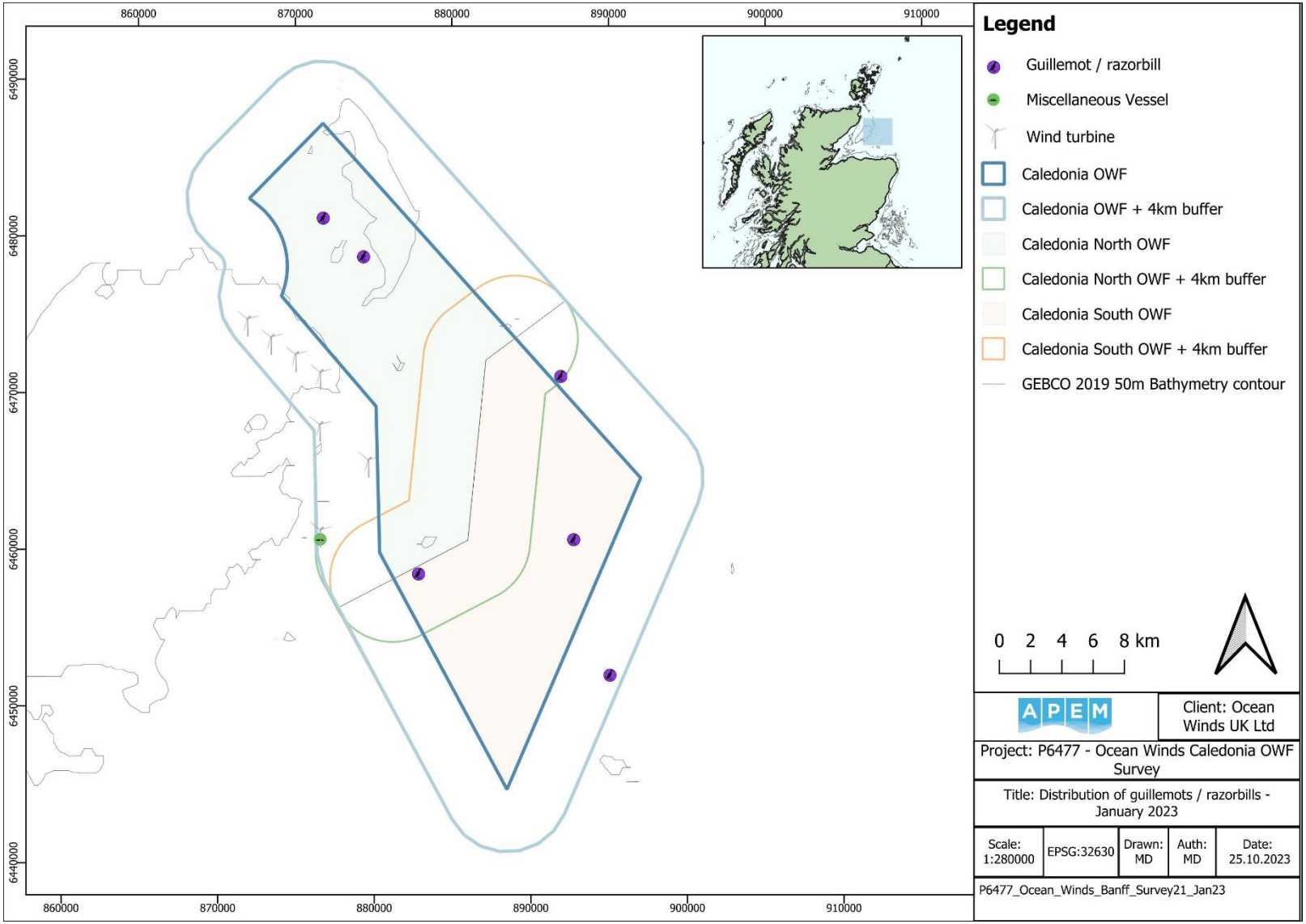



**Figure A4.212 Distribution of guillemots / razorbills recorded in the Survey Area in January 2023**

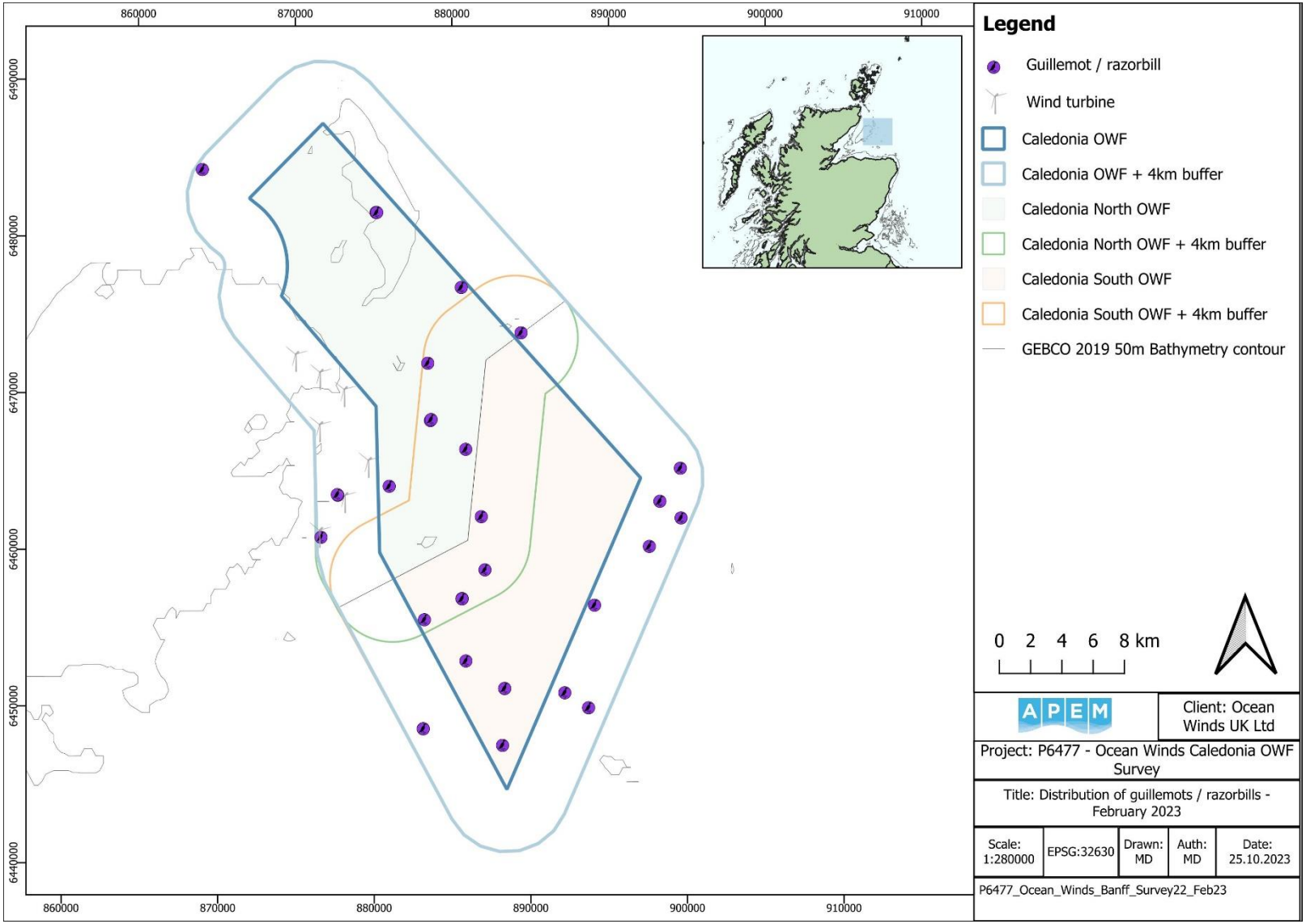



**Figure A4.213 Distribution of guillemots / razorbills recorded in the Survey Area in February 2023**

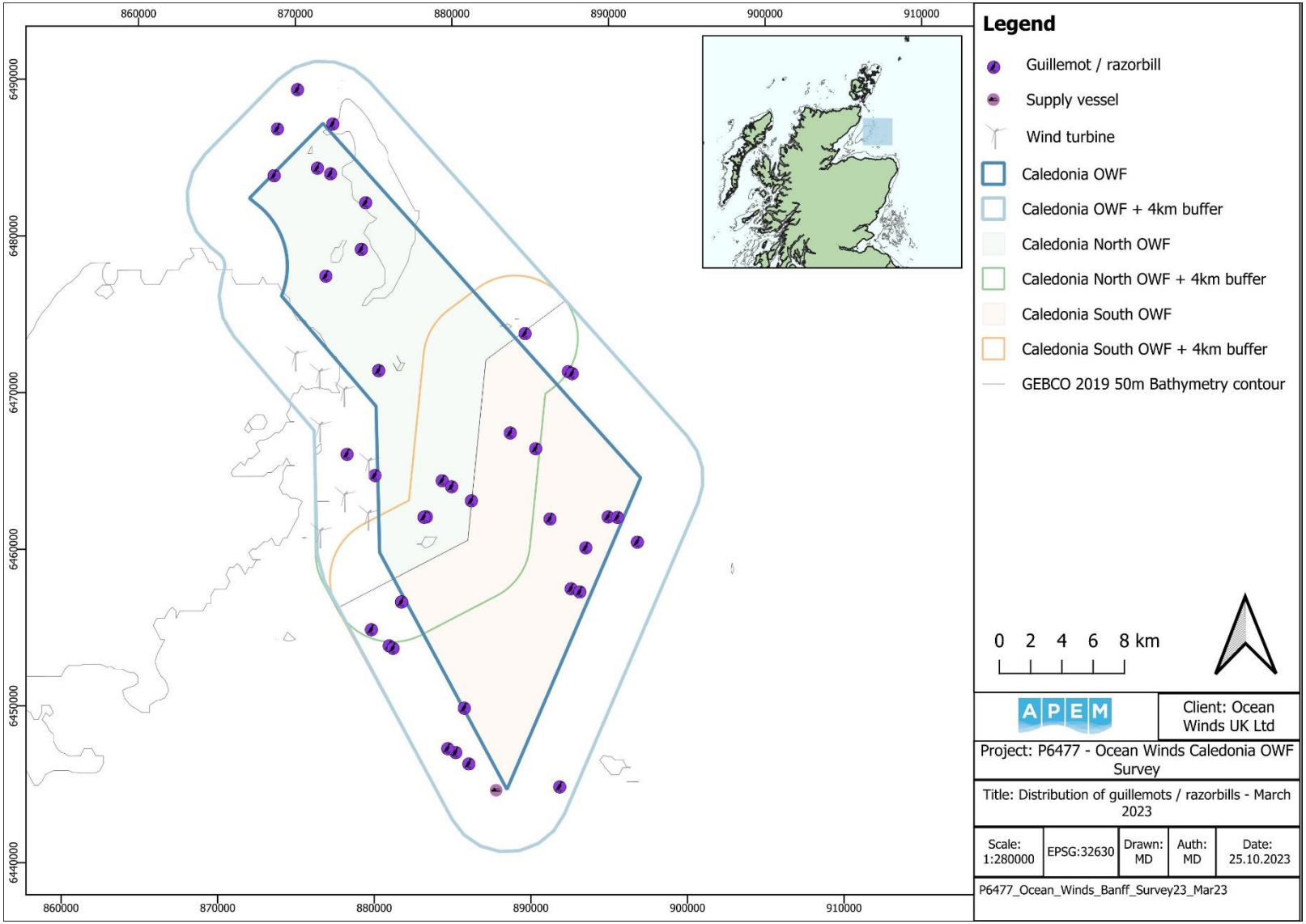



**Figure A4.214 Distribution of guillemots / razorbills recorded in the Survey Area in March 2023**

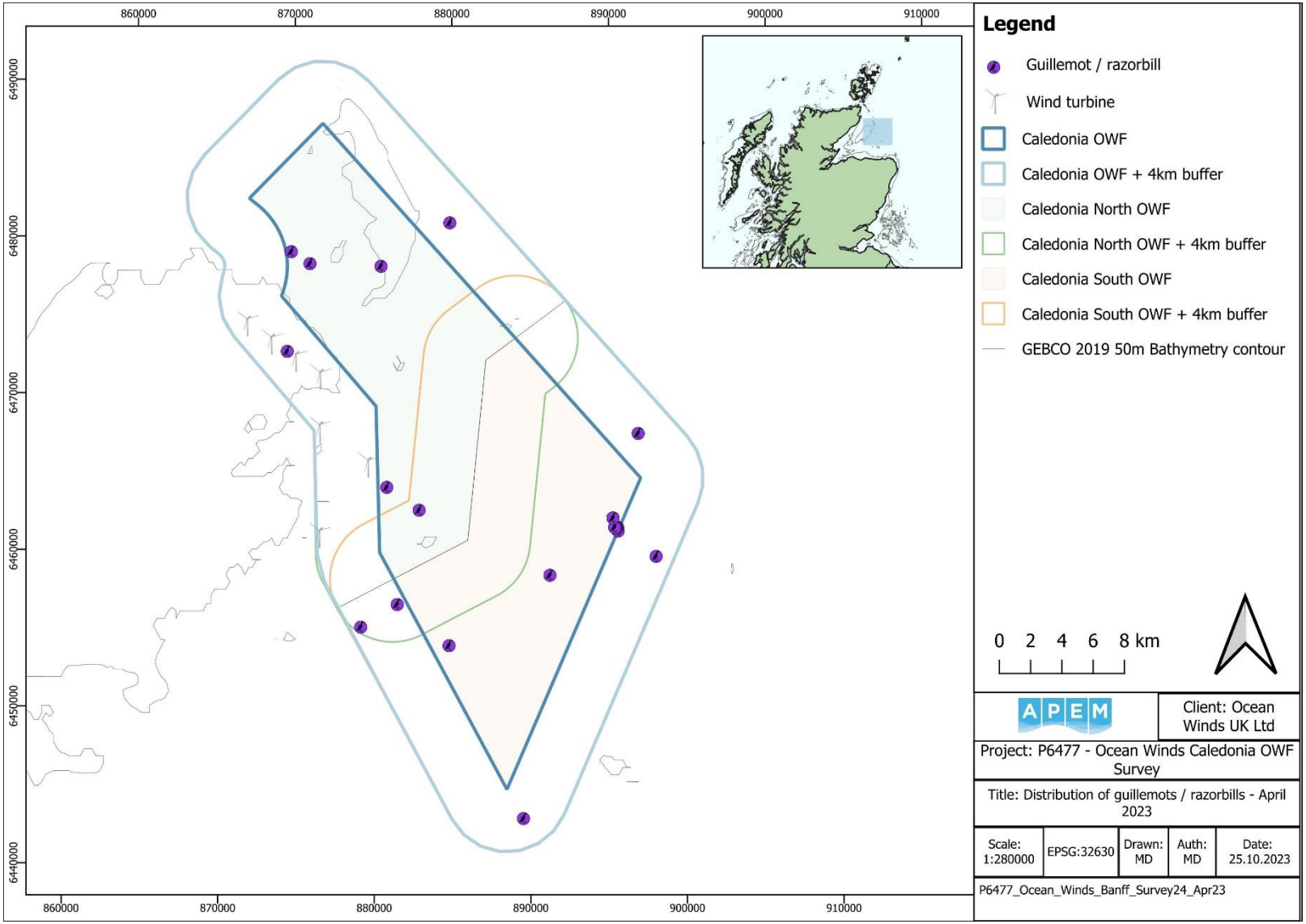



**Figure A4.215 Distribution of guillemots / razorbills recorded in the Survey Area in April 2023**

## Black guillemot

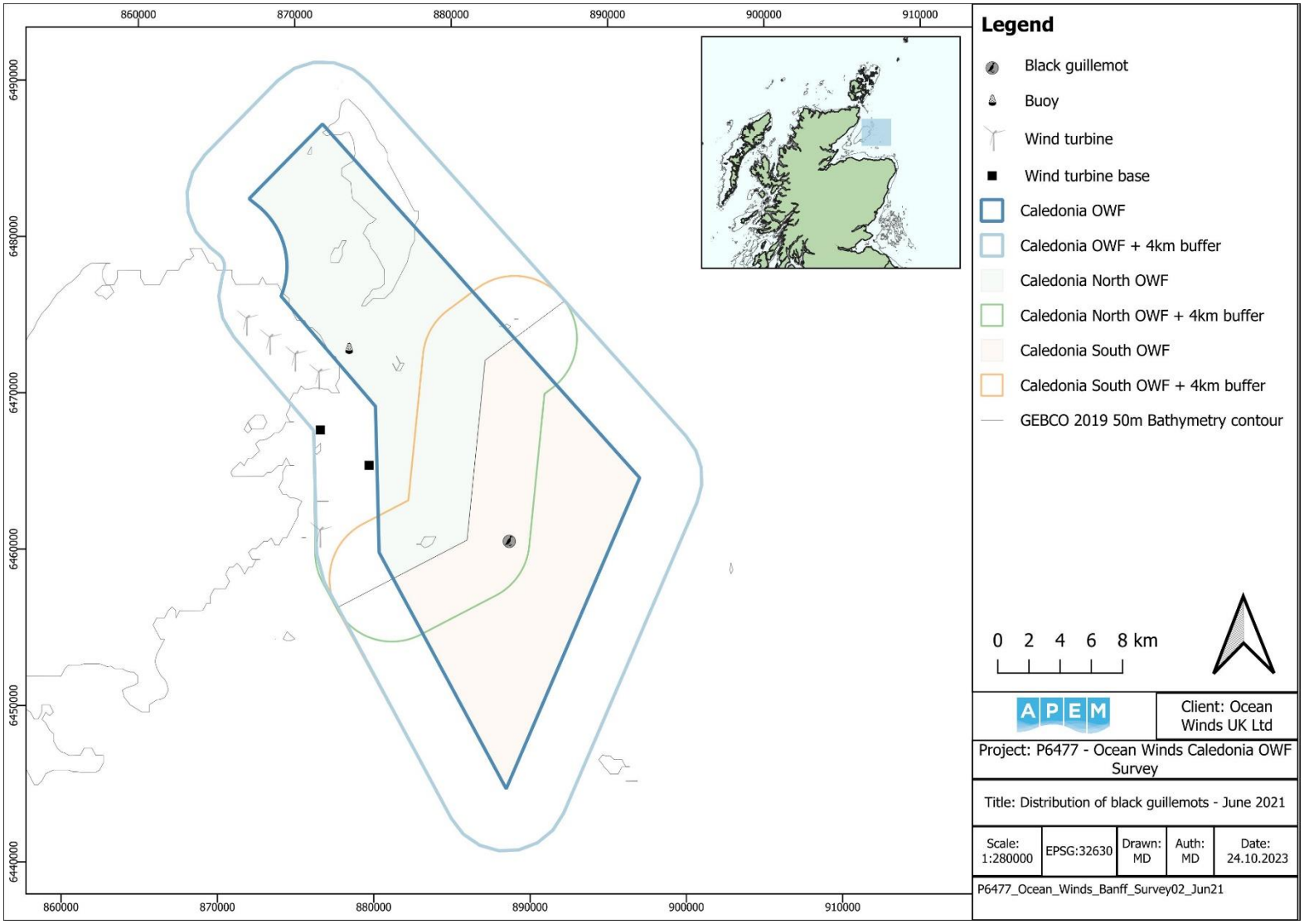



**Figure A4.216 Distribution of black guillemots recorded in the Survey Area in June 2021**

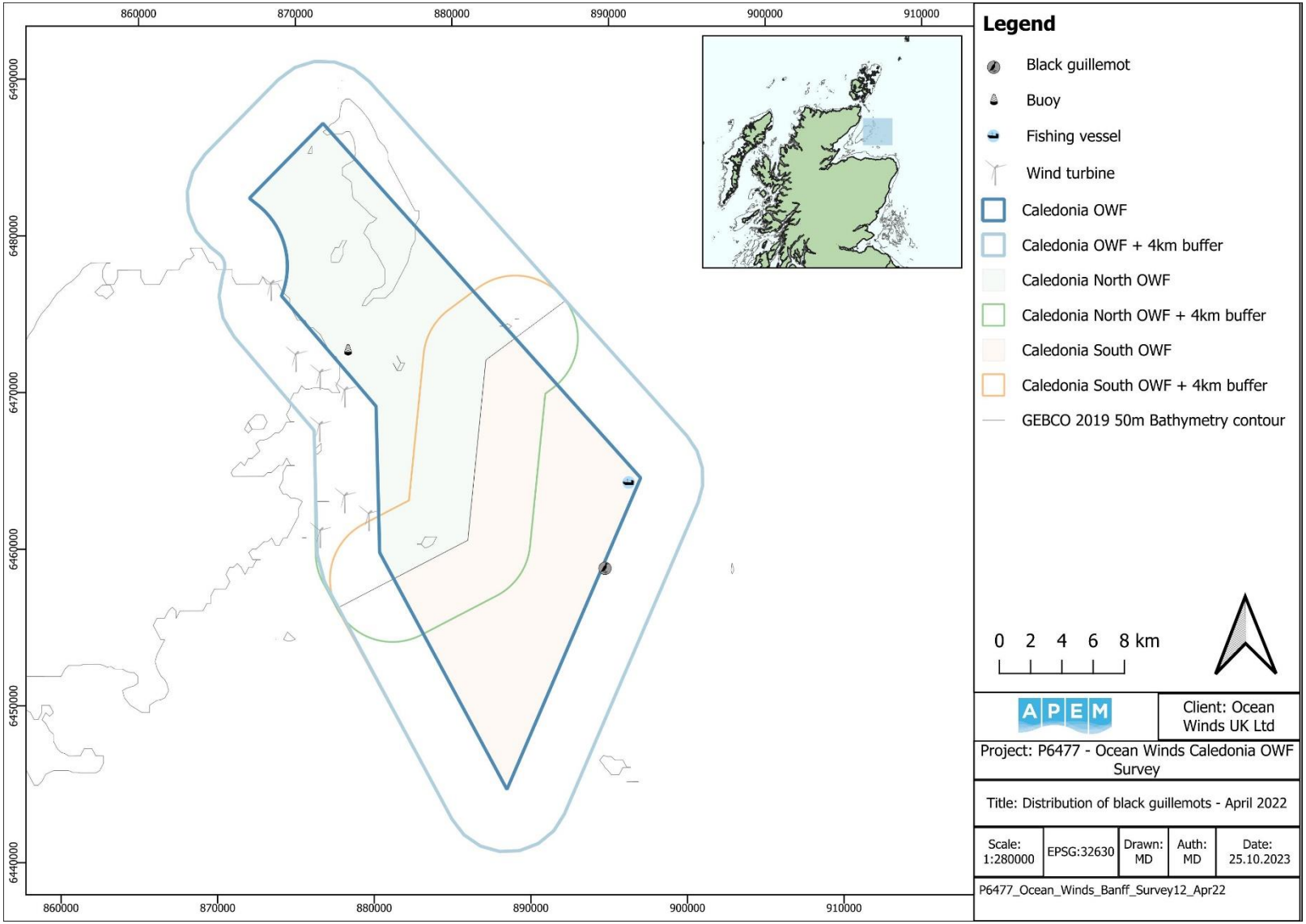



**Figure A4.217 Distribution of black guillemots recorded in the Survey Area in April 2022**

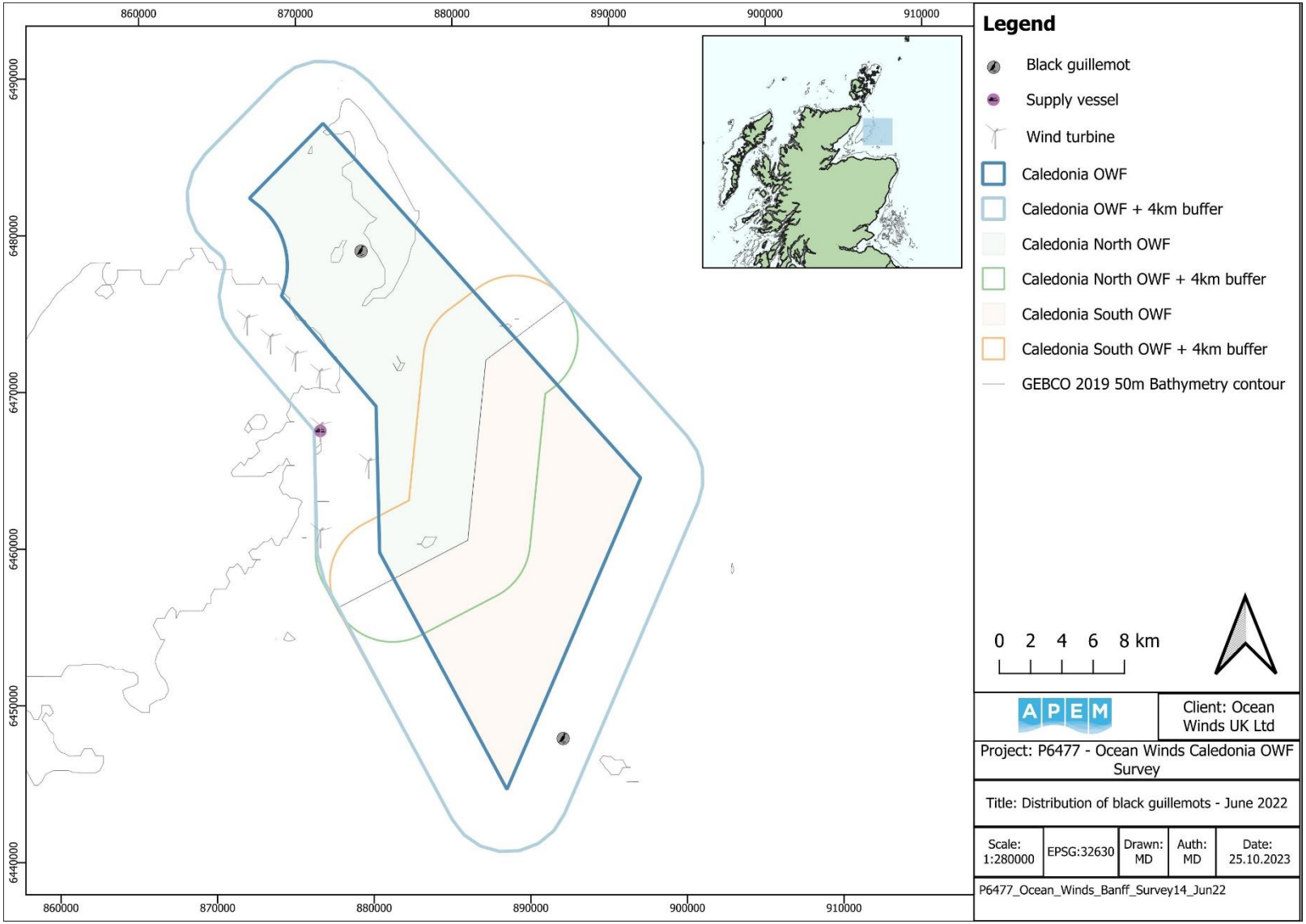



**Figure A4.218 Distribution of black guillemots recorded in the Survey Area in June 2022**

## Puffin

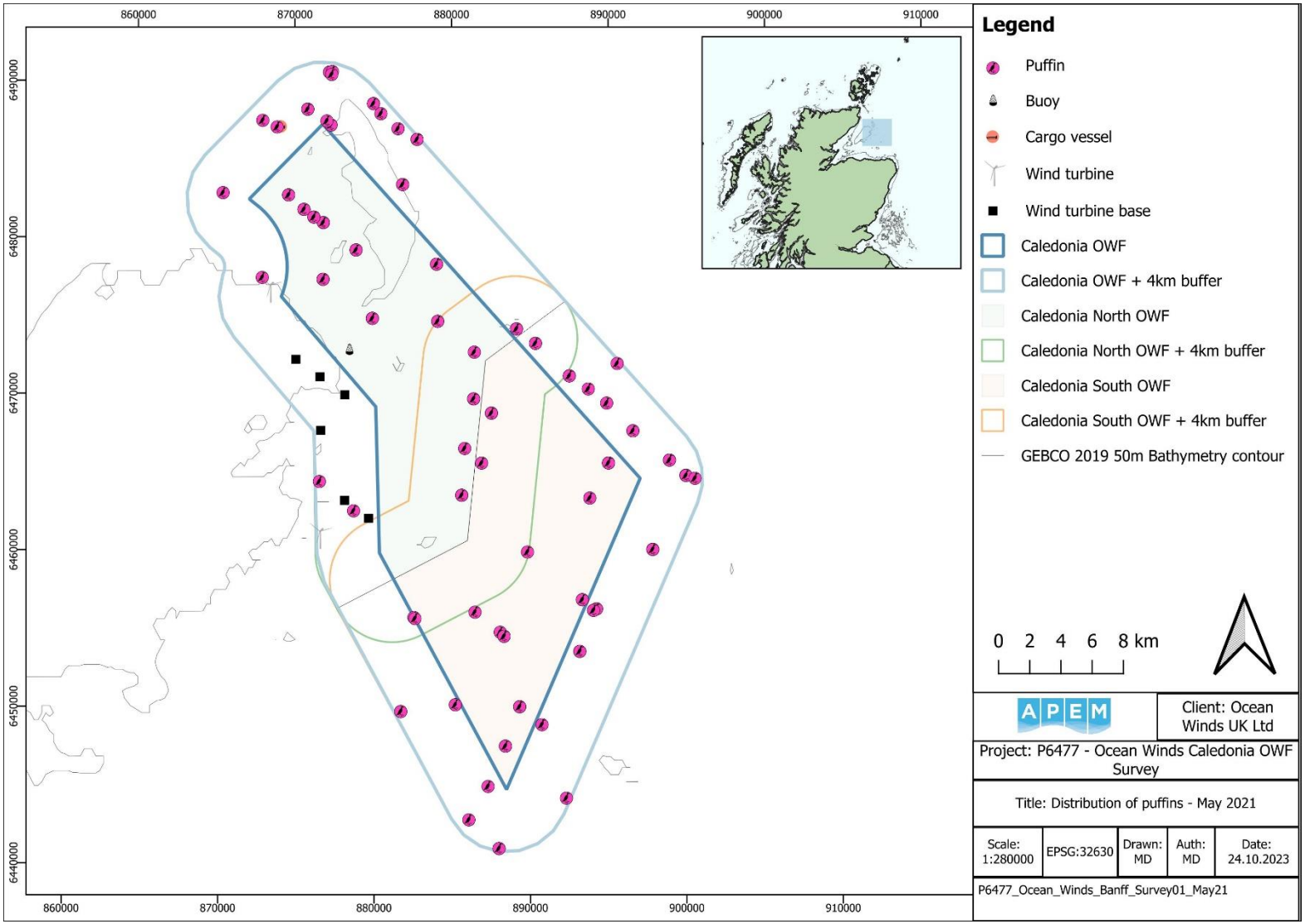



**Figure A4.219 Distribution of puffins recorded in the Survey Area in May 2021**

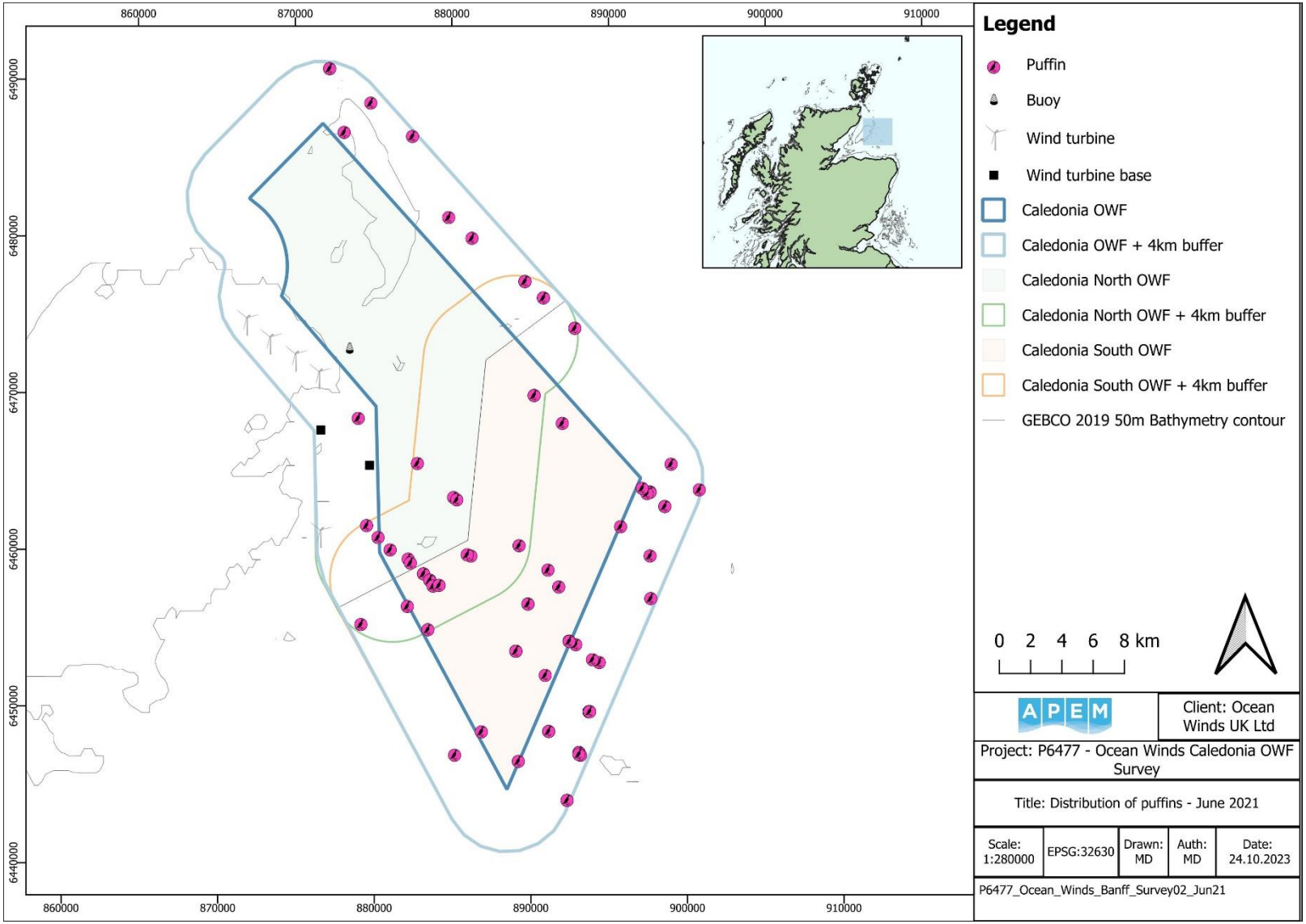



**Figure A4.220 Distribution of puffins recorded in the Survey Area in June 2021**

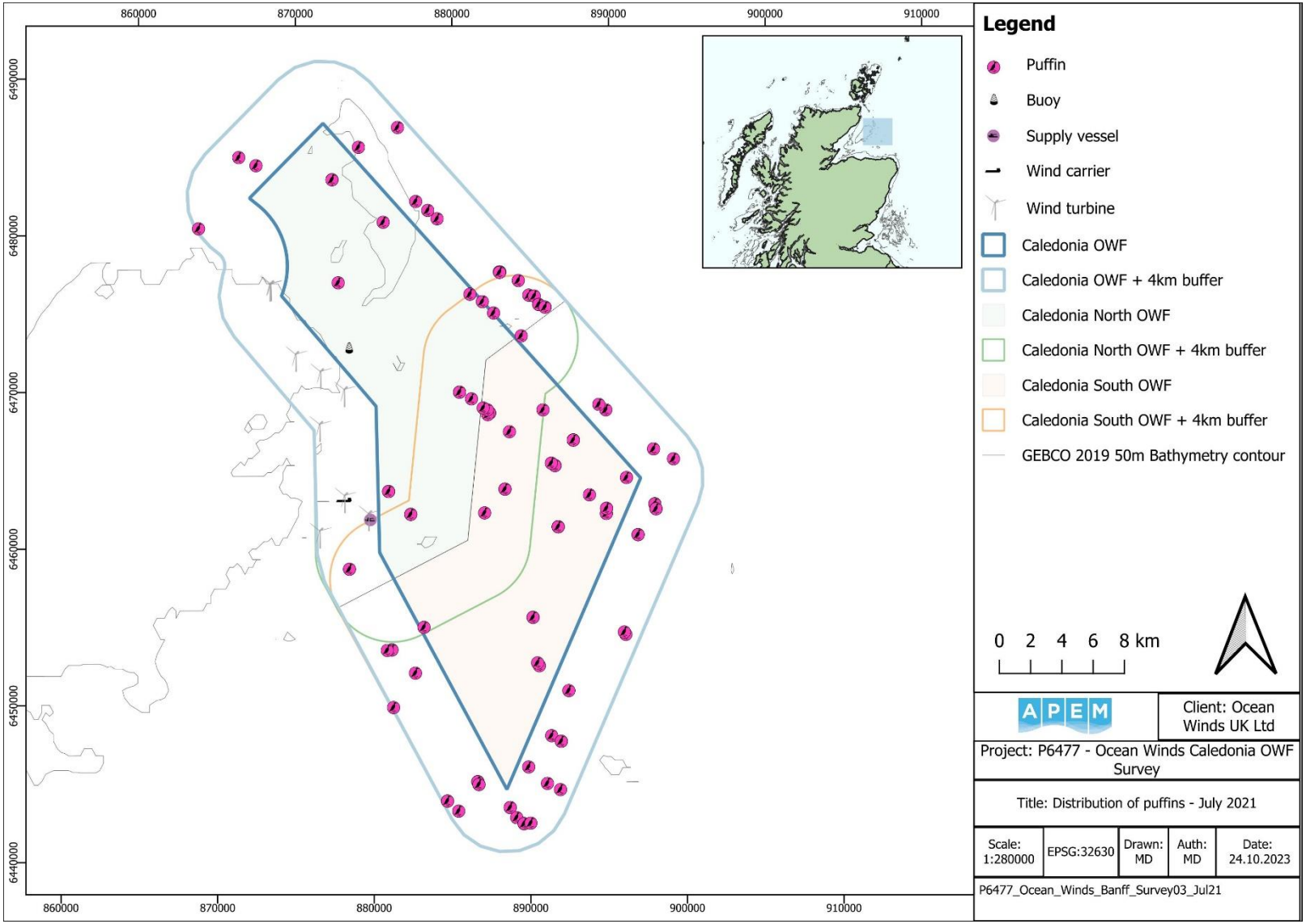



**Figure A4.221 Distribution of puffins recorded in the Survey Area in July 2021**

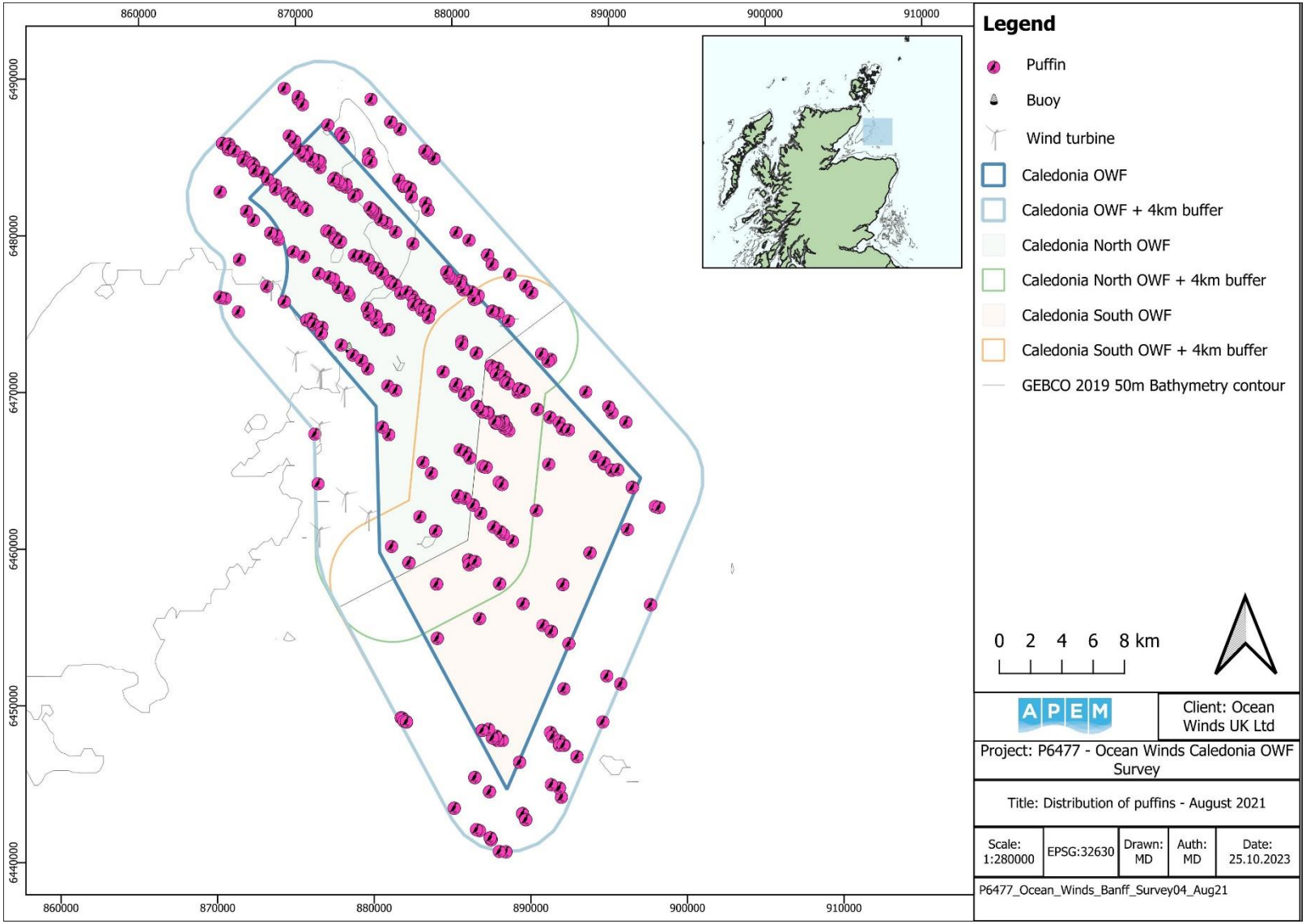



**Figure A4.222 Distribution of puffins recorded in the Survey Area in August 2021**

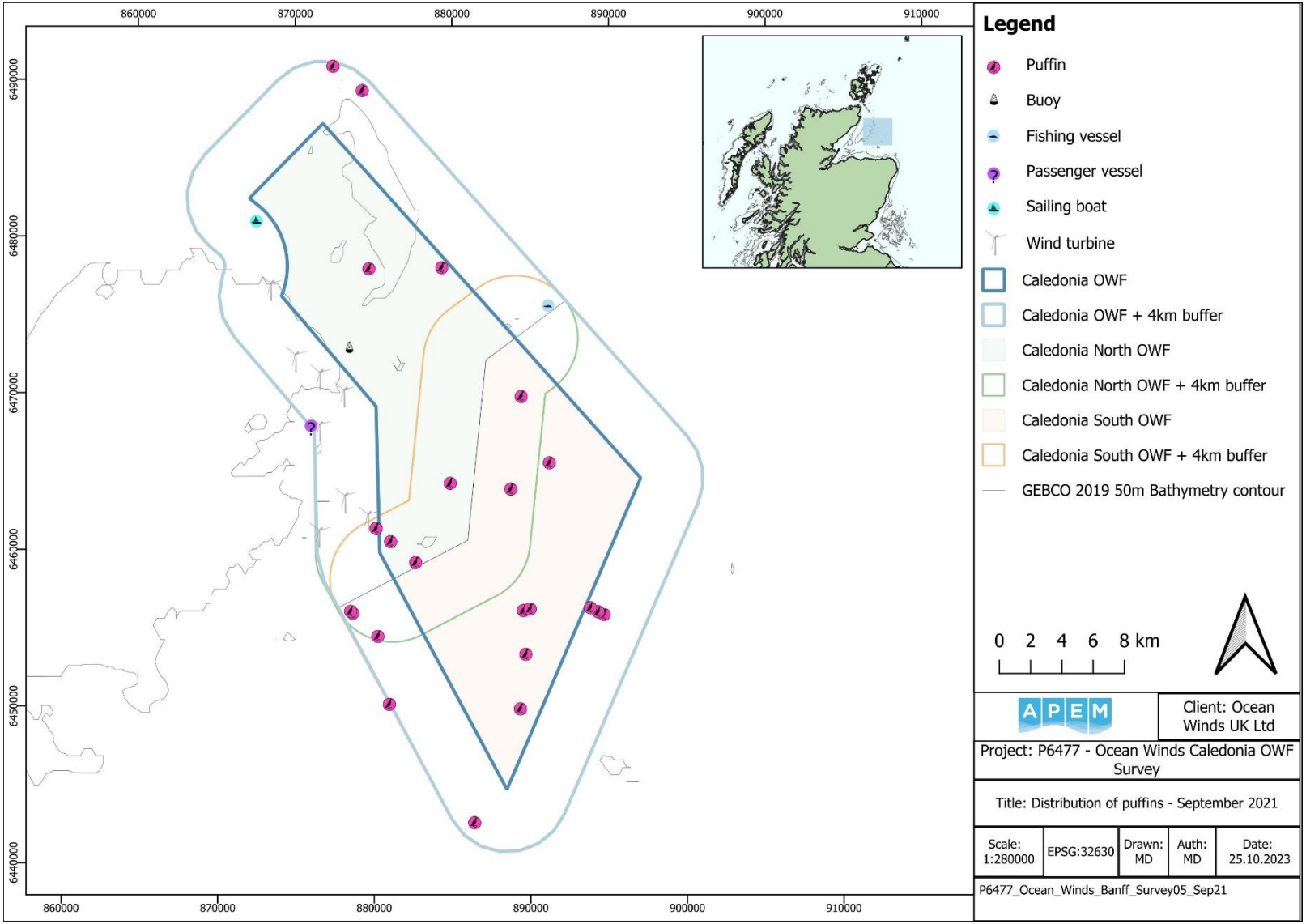



**Figure A4.223 Distribution of puffins recorded in the Survey Area in September 2021**

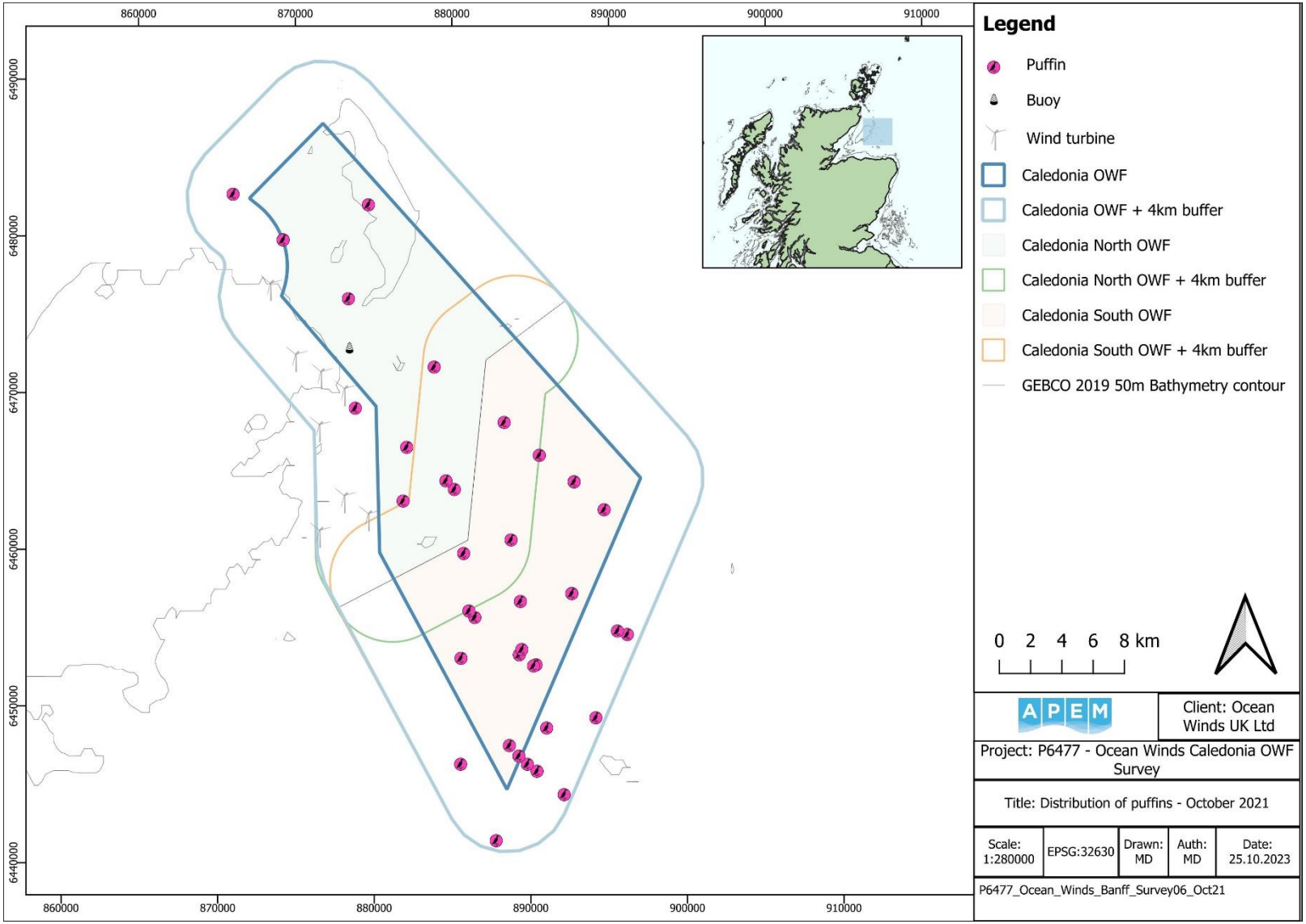



**Figure A4.224 Distribution of puffins recorded in the Survey Area in October 2021**

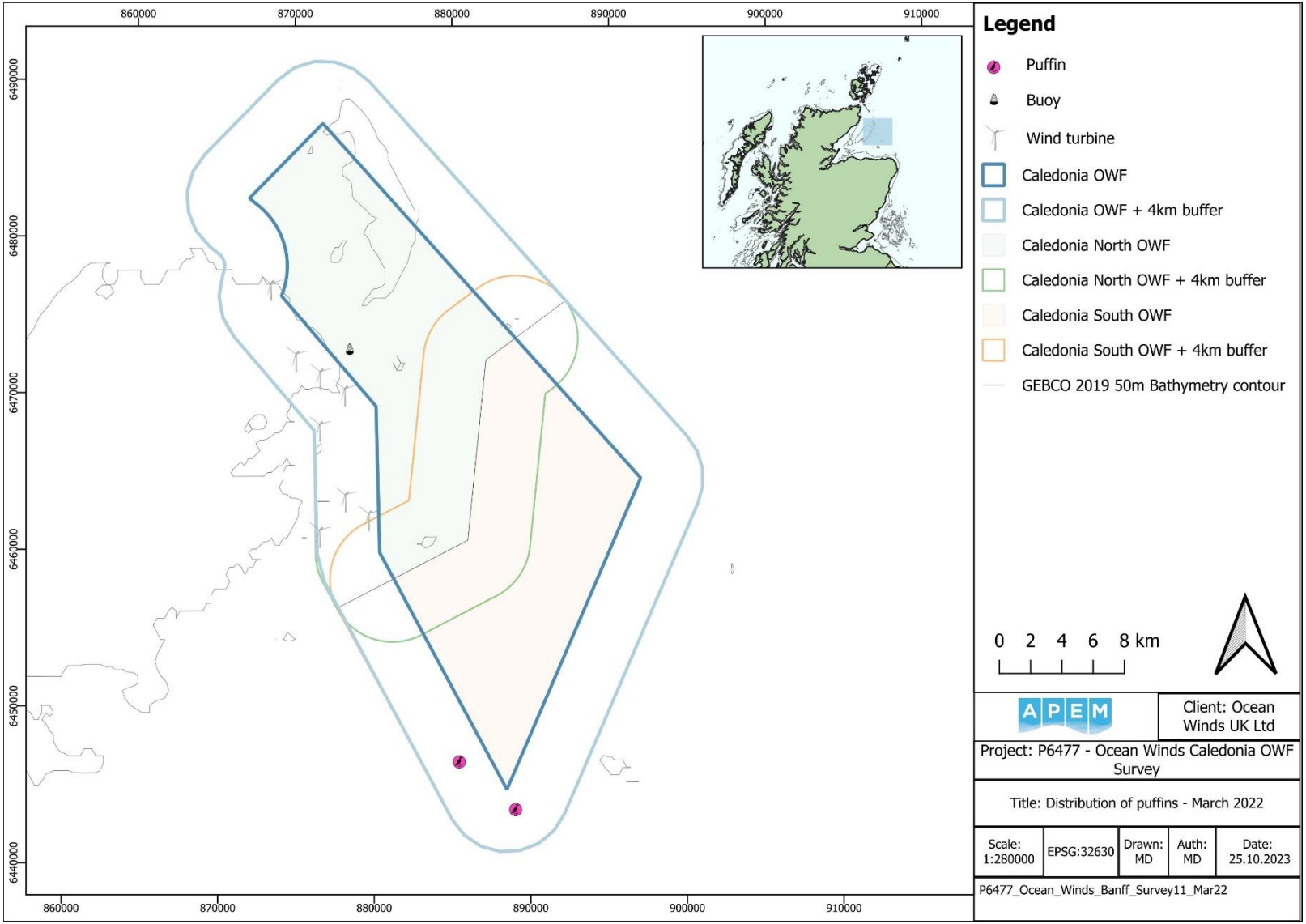



**Figure A4.225 Distribution of puffins recorded in the Survey Area in March 2022**

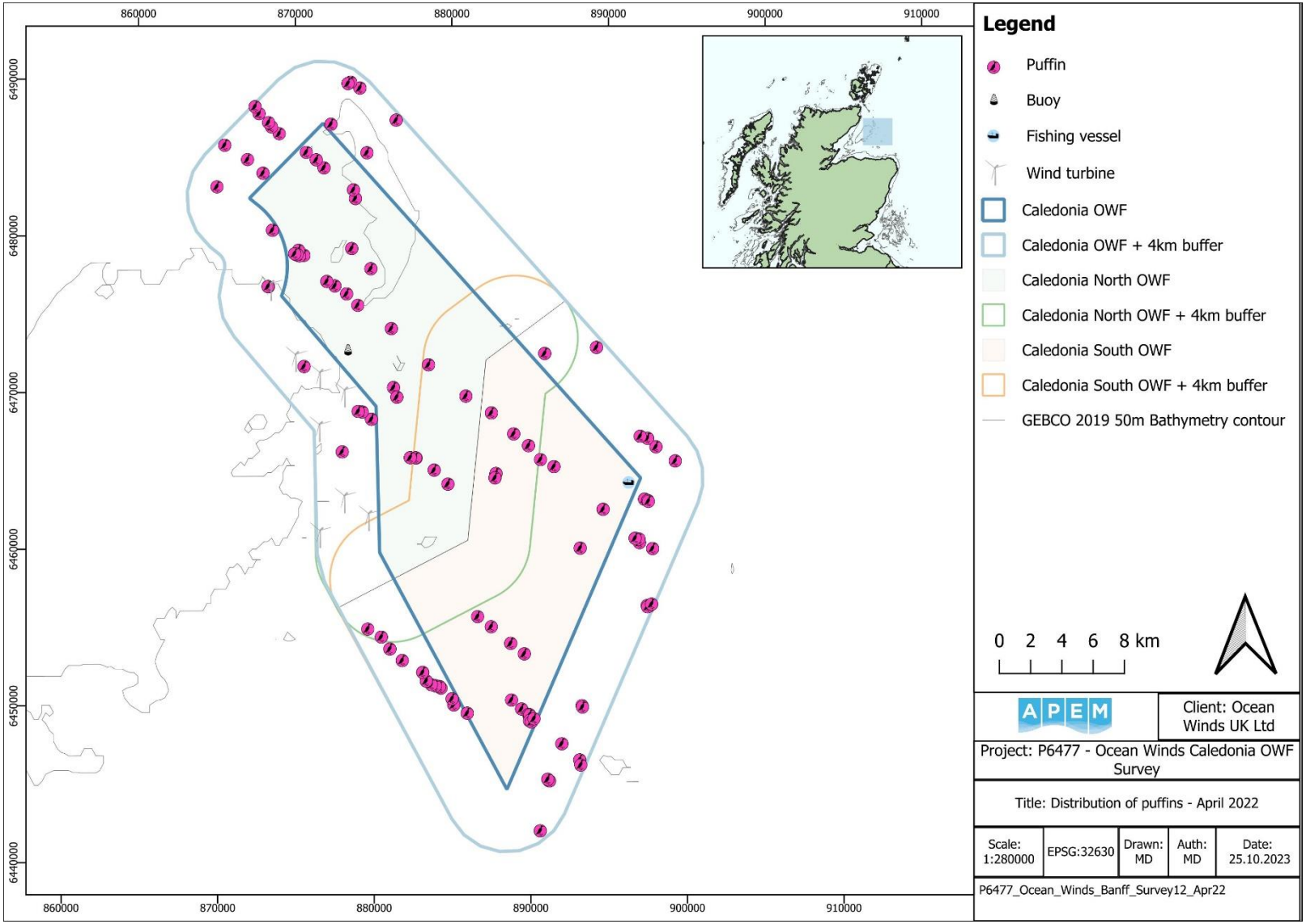



**Figure A4.226 Distribution of puffins recorded in the Survey Area in April 2022**

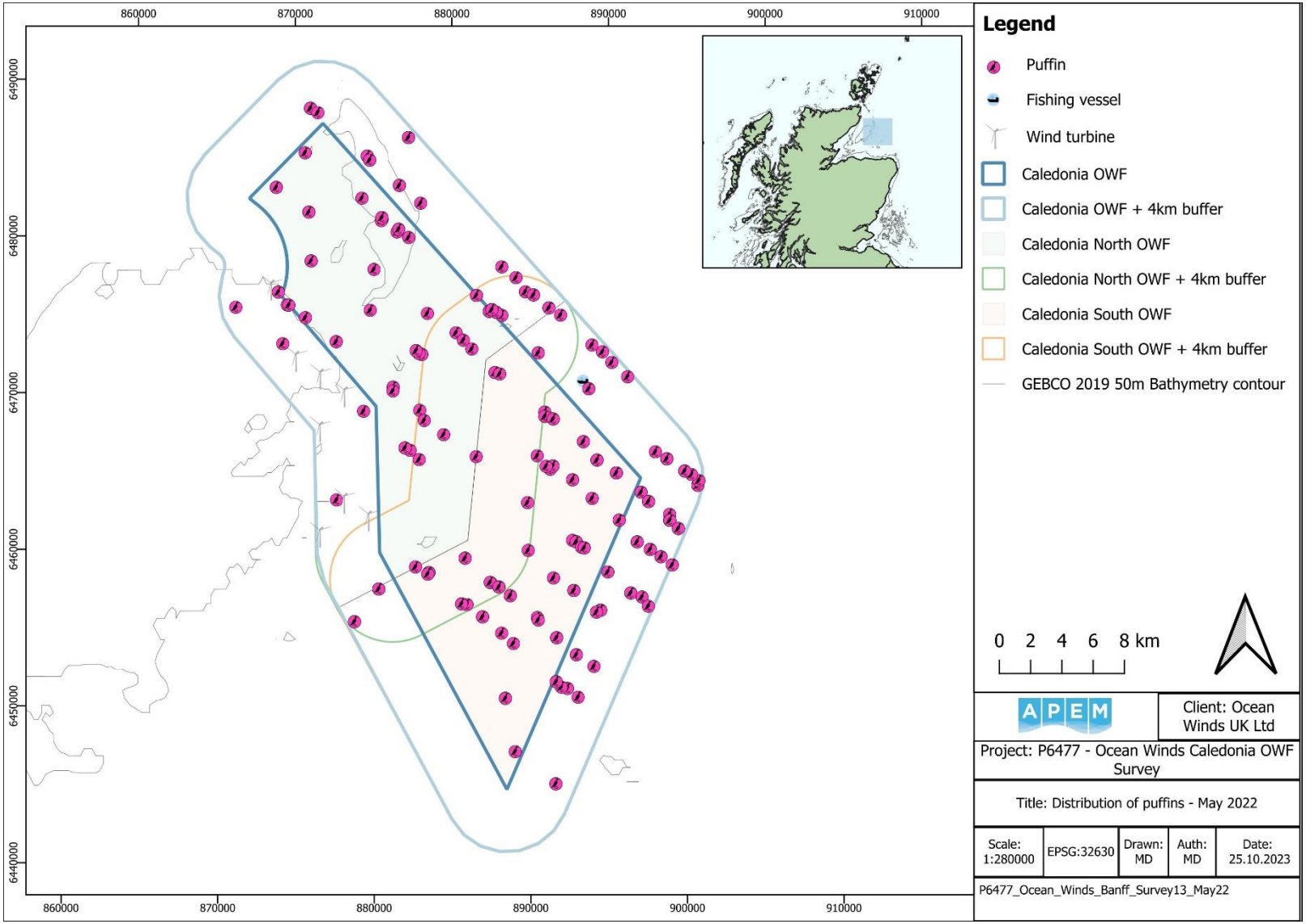



**Figure A4.227 Distribution of puffins recorded in the Survey Area in May 2022**

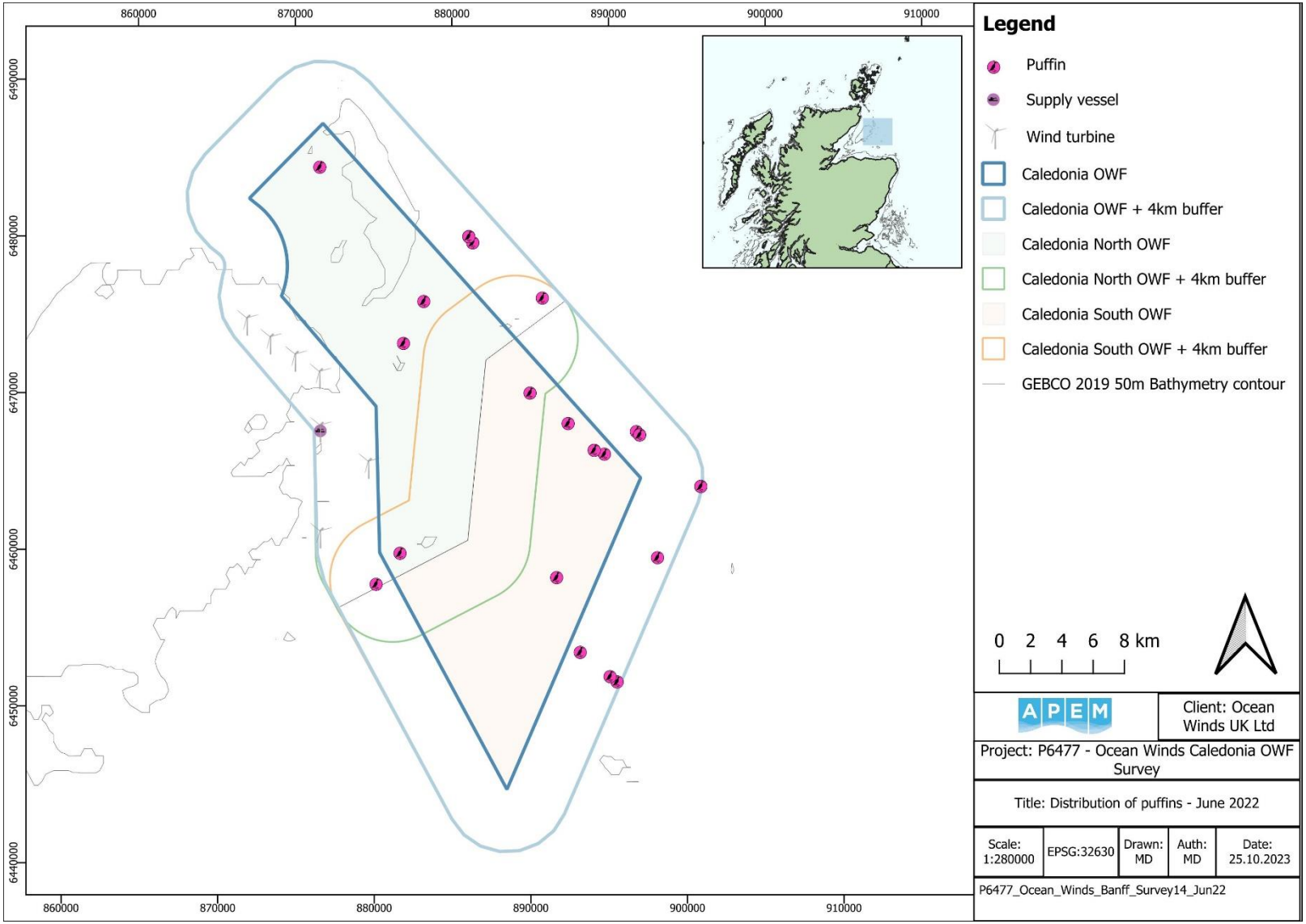



**Figure A4.228 Distribution of puffins recorded in the Survey Area in June 2022**

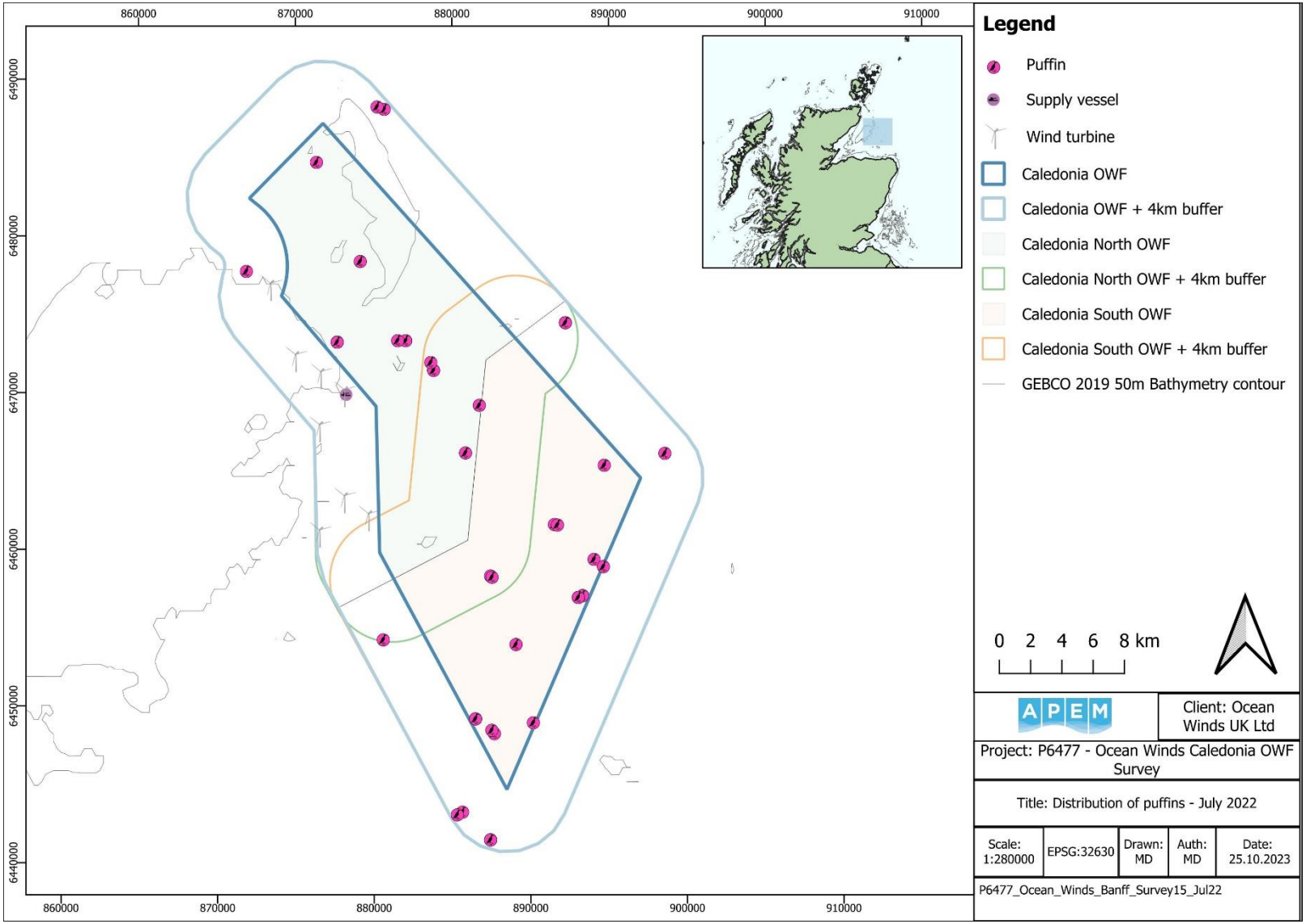



**Figure A4.229 Distribution of puffins recorded in the Survey Area in July 2022**

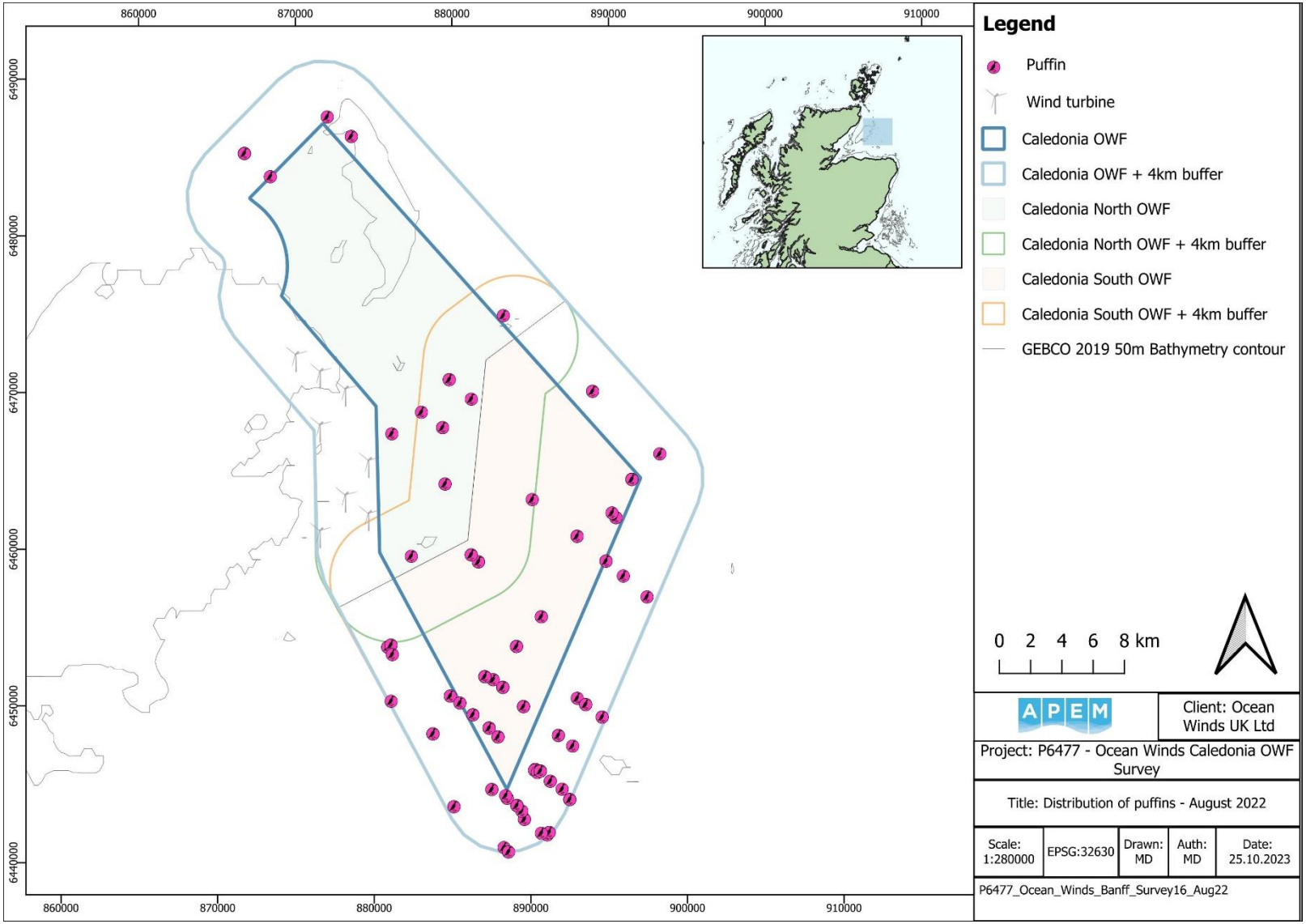



**Figure A4.230 Distribution of puffins recorded in the Survey Area in August 2022**

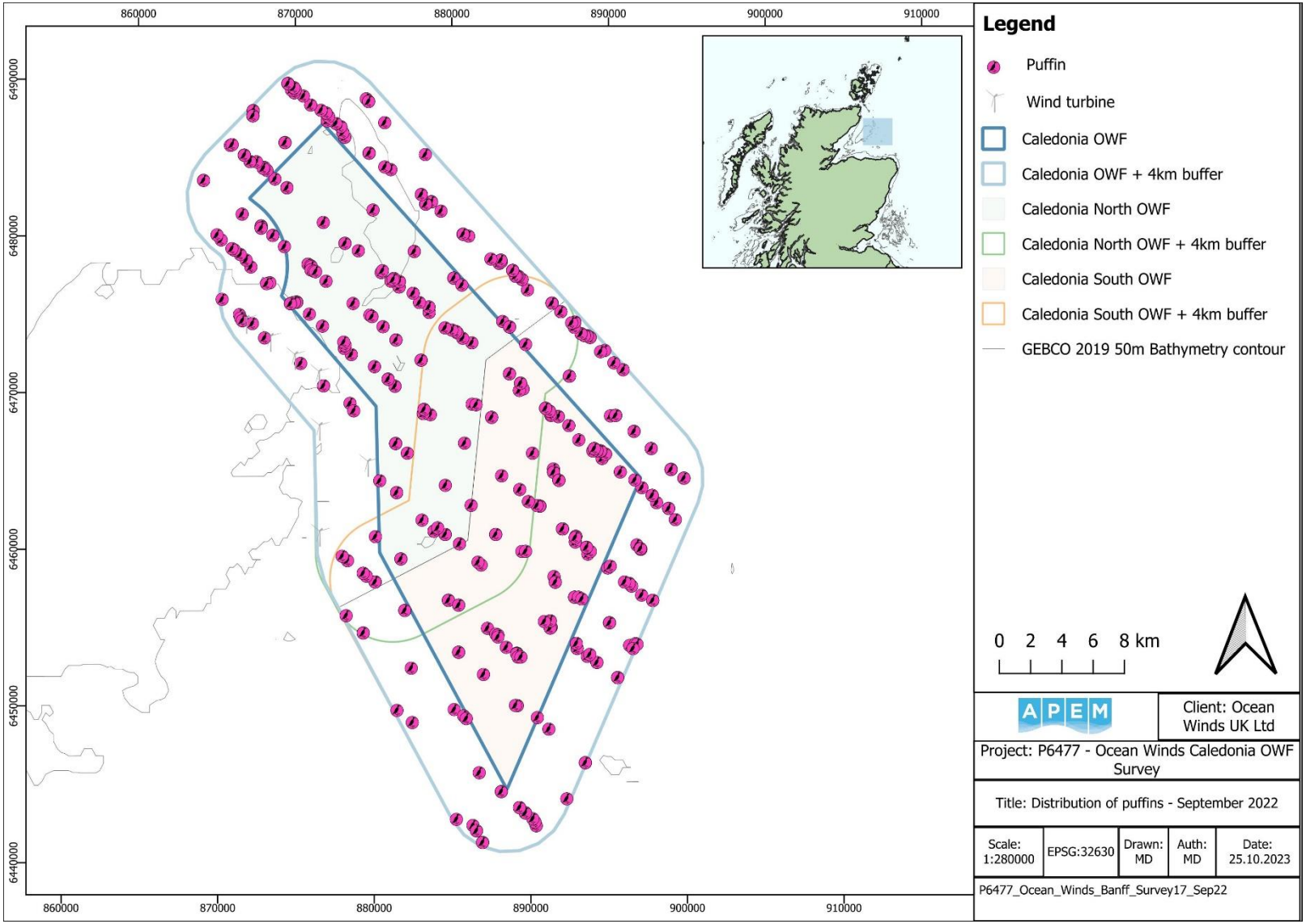



**Figure A4.231 Distribution of puffins recorded in the Survey Area in September 2022**

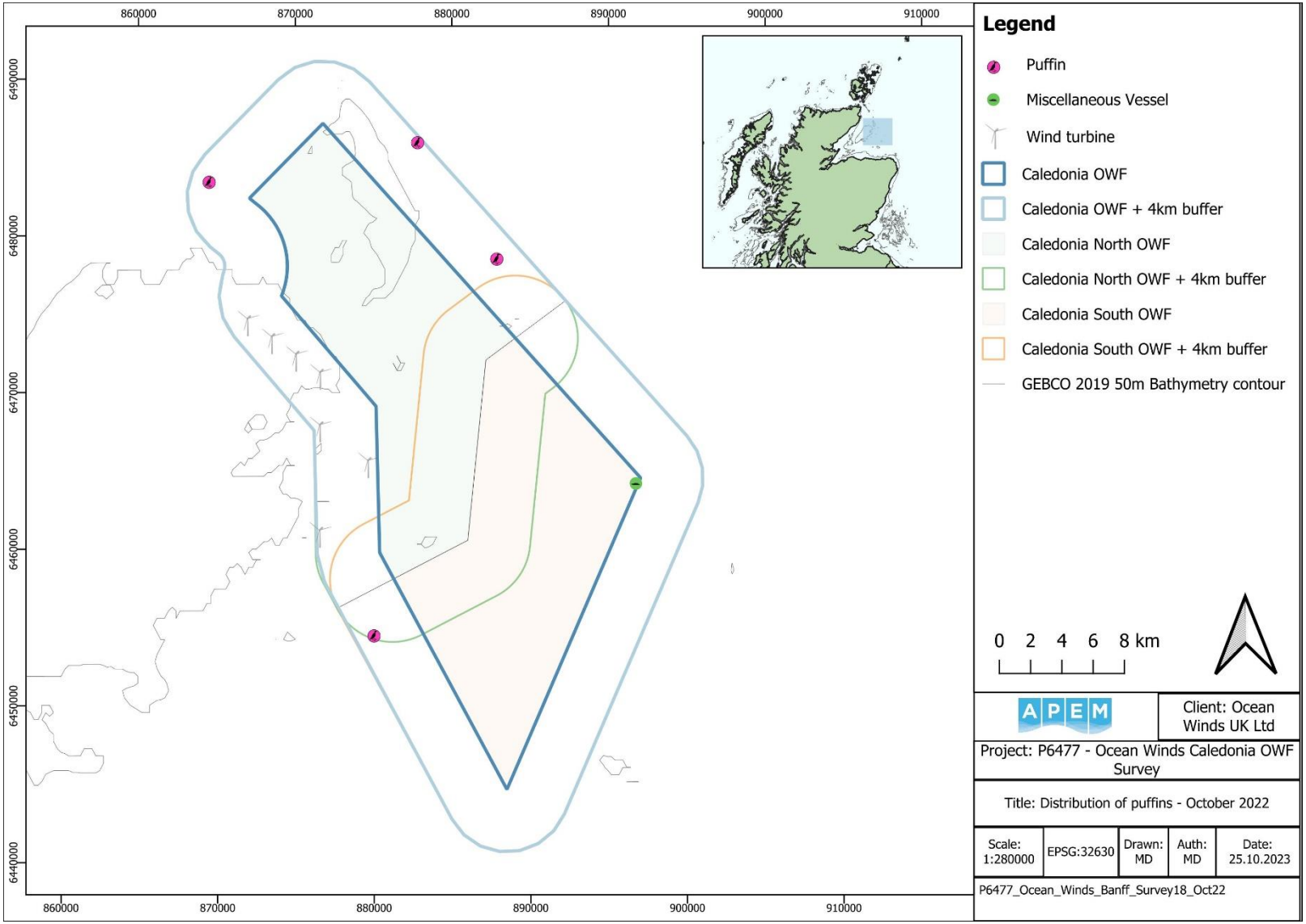



**Figure A4.232 Distribution of puffins recorded in the Survey Area in October 2022**

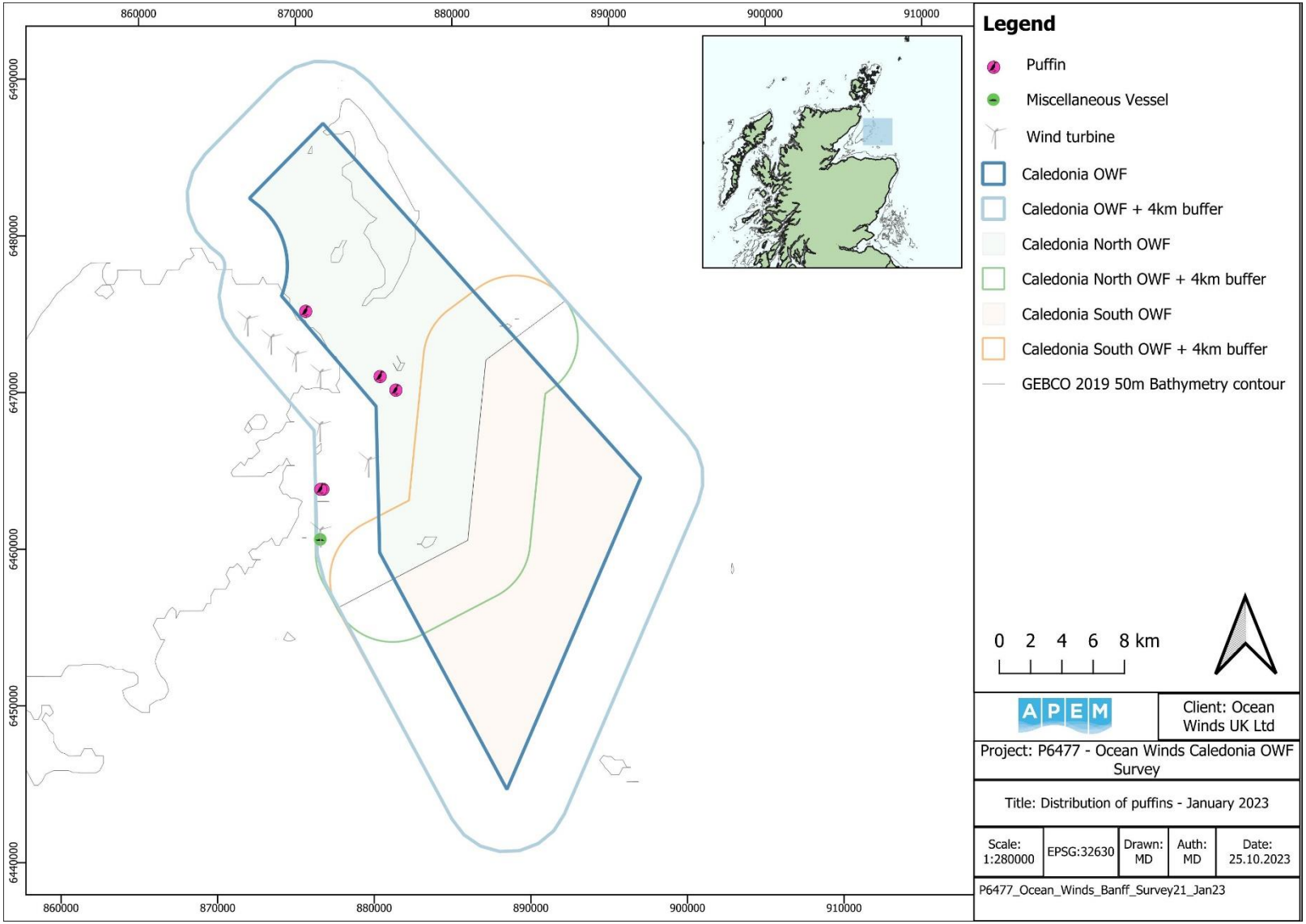



**Figure A4.233 Distribution of puffins recorded in the Survey Area in January 2023**

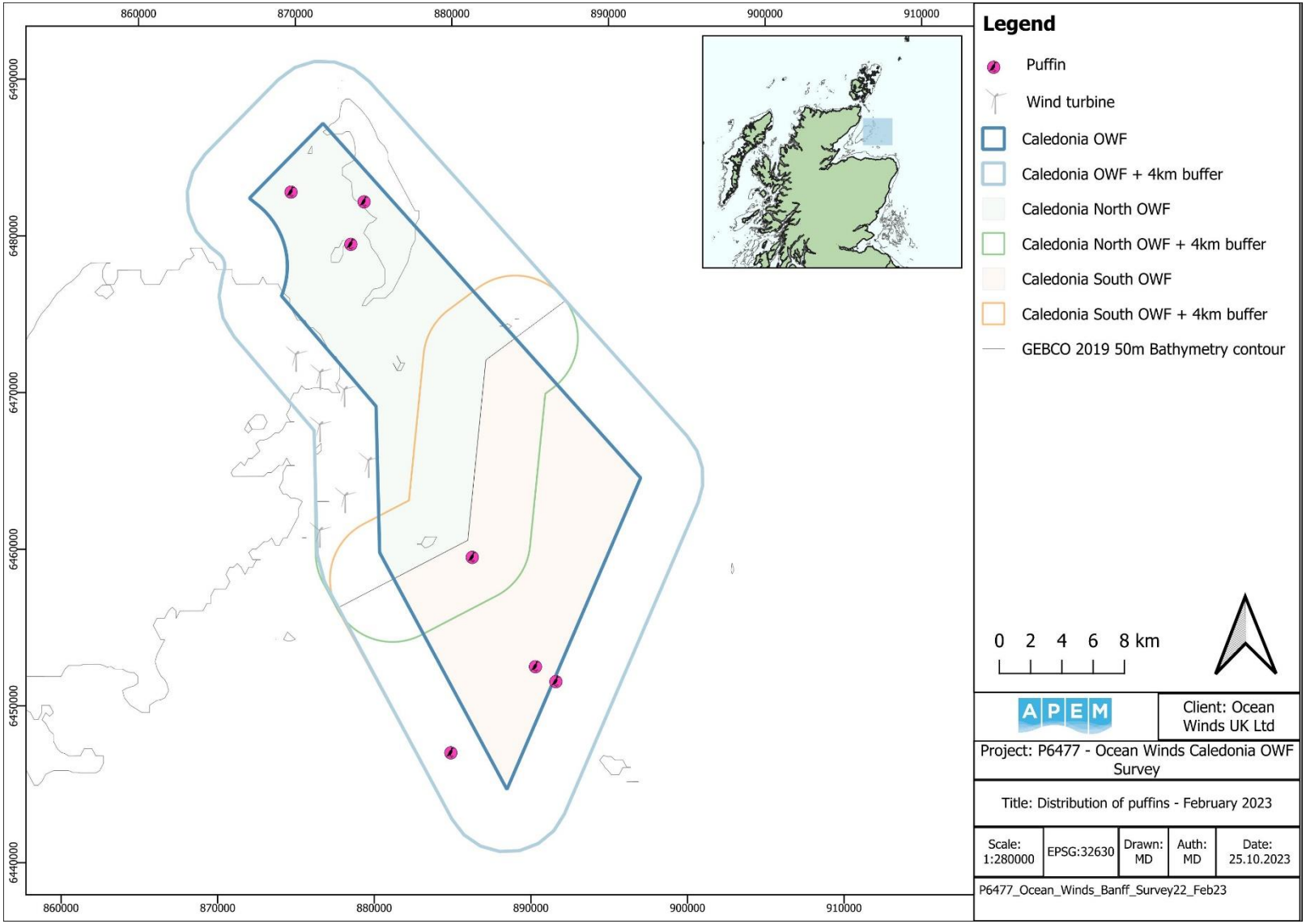



**Figure A4.234 Distribution of puffins recorded in the Survey Area in February 2023**

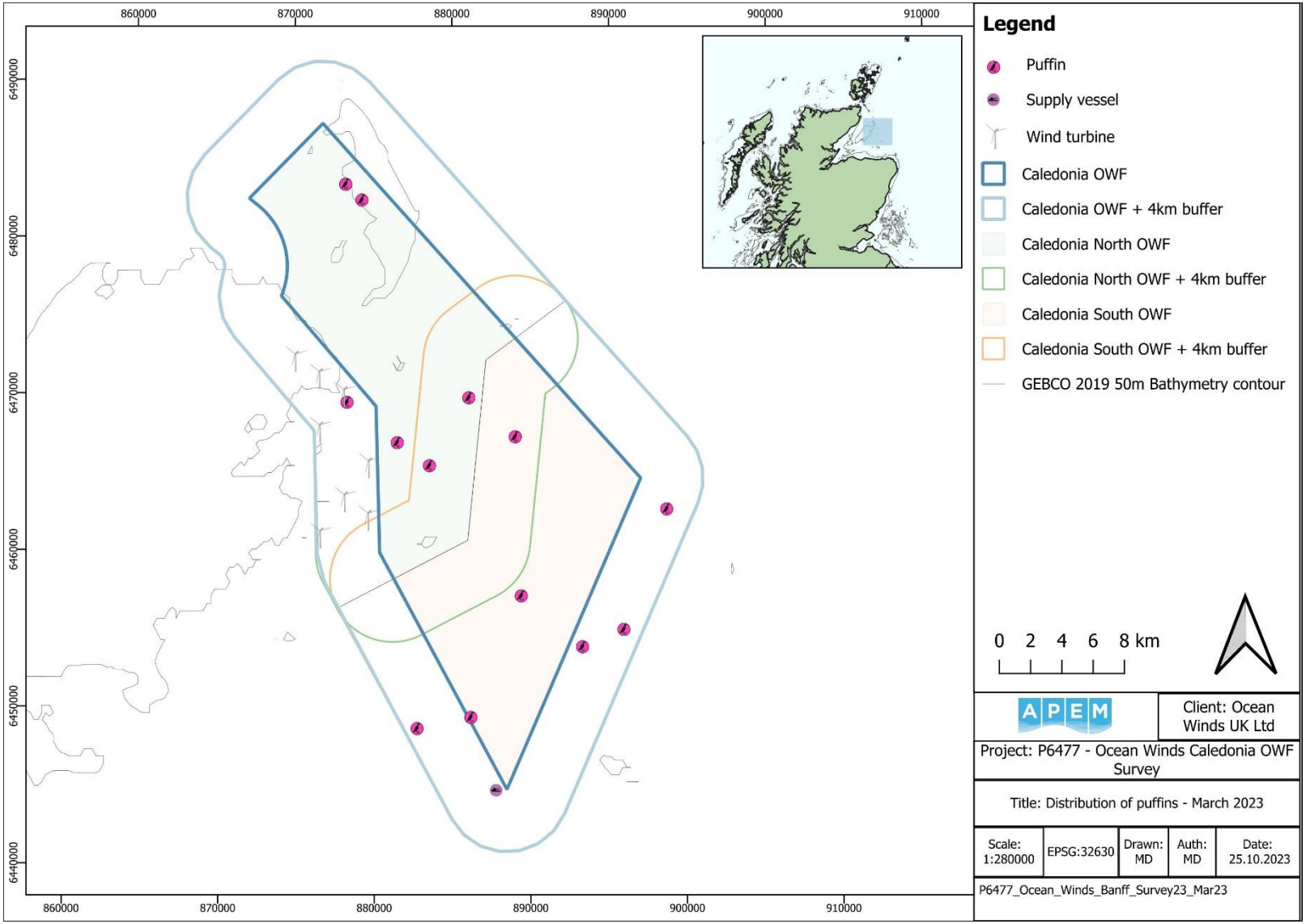



**Figure A4.235 Distribution of puffins recorded in the Survey Area in March 2023**

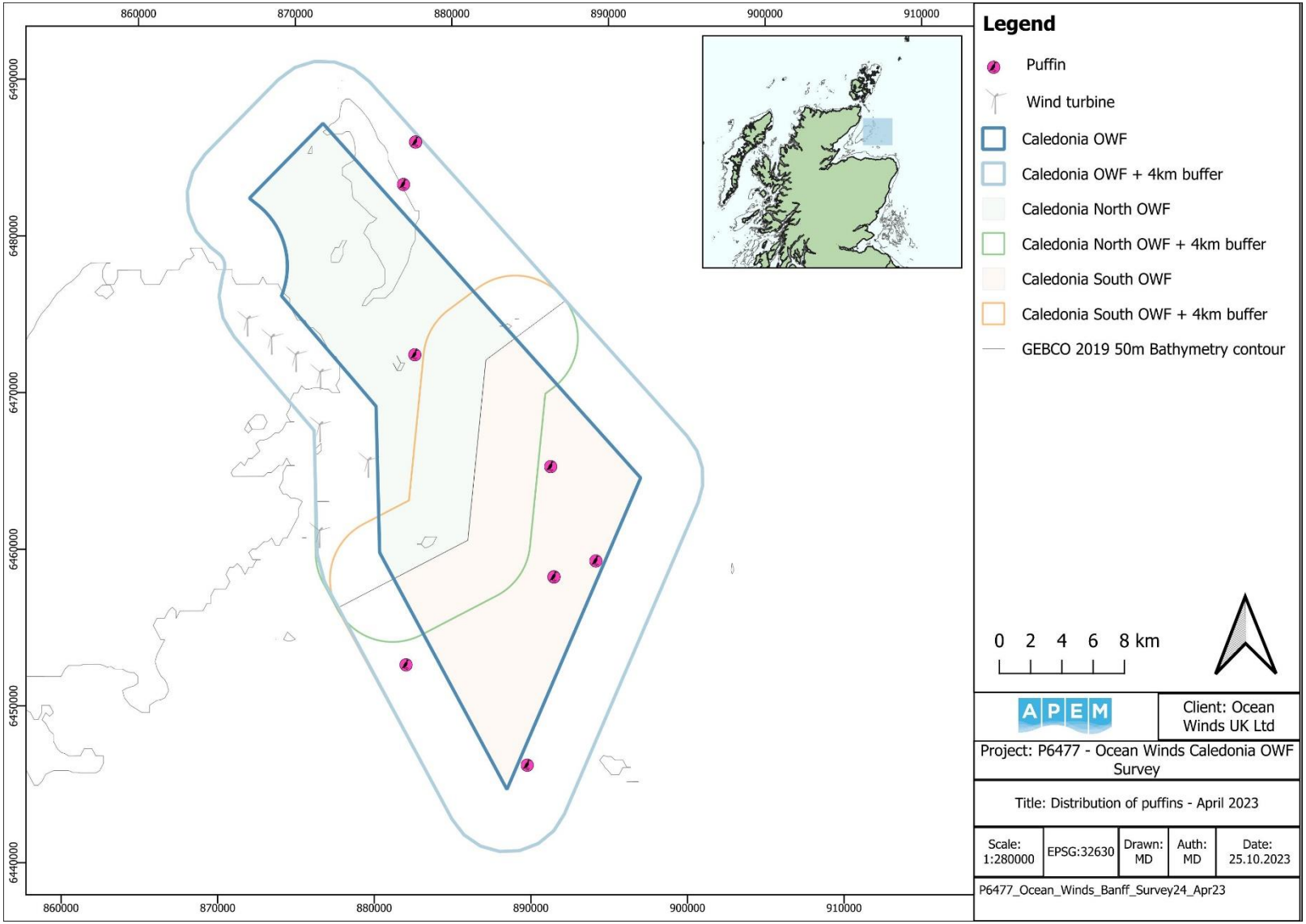



**Figure A4.236 Distribution of puffins recorded in the Survey Area in April 2023**

## Unidentified auk species

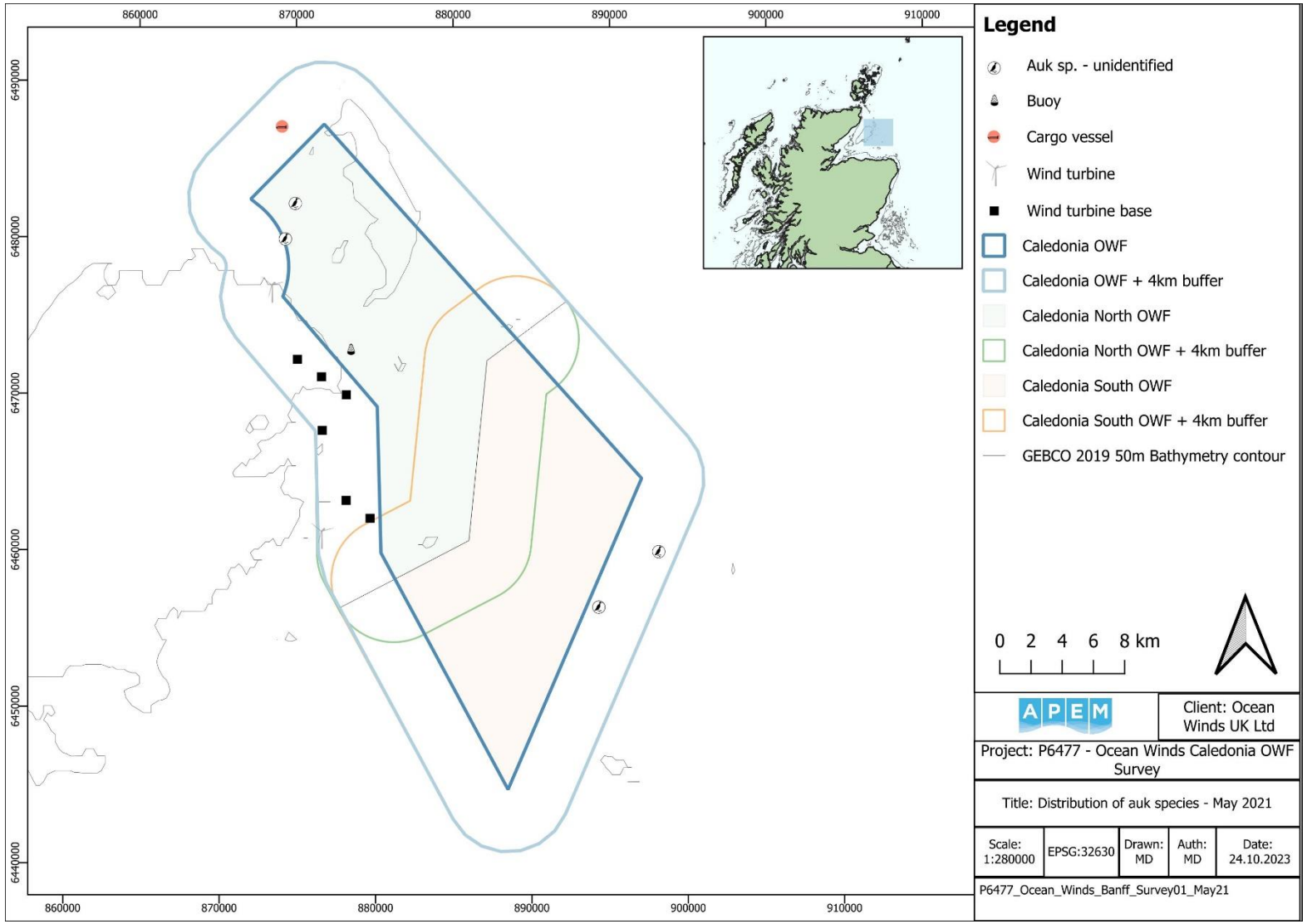



**Figure A4.237 Distribution of auk species recorded in the Survey Area in May 2021**

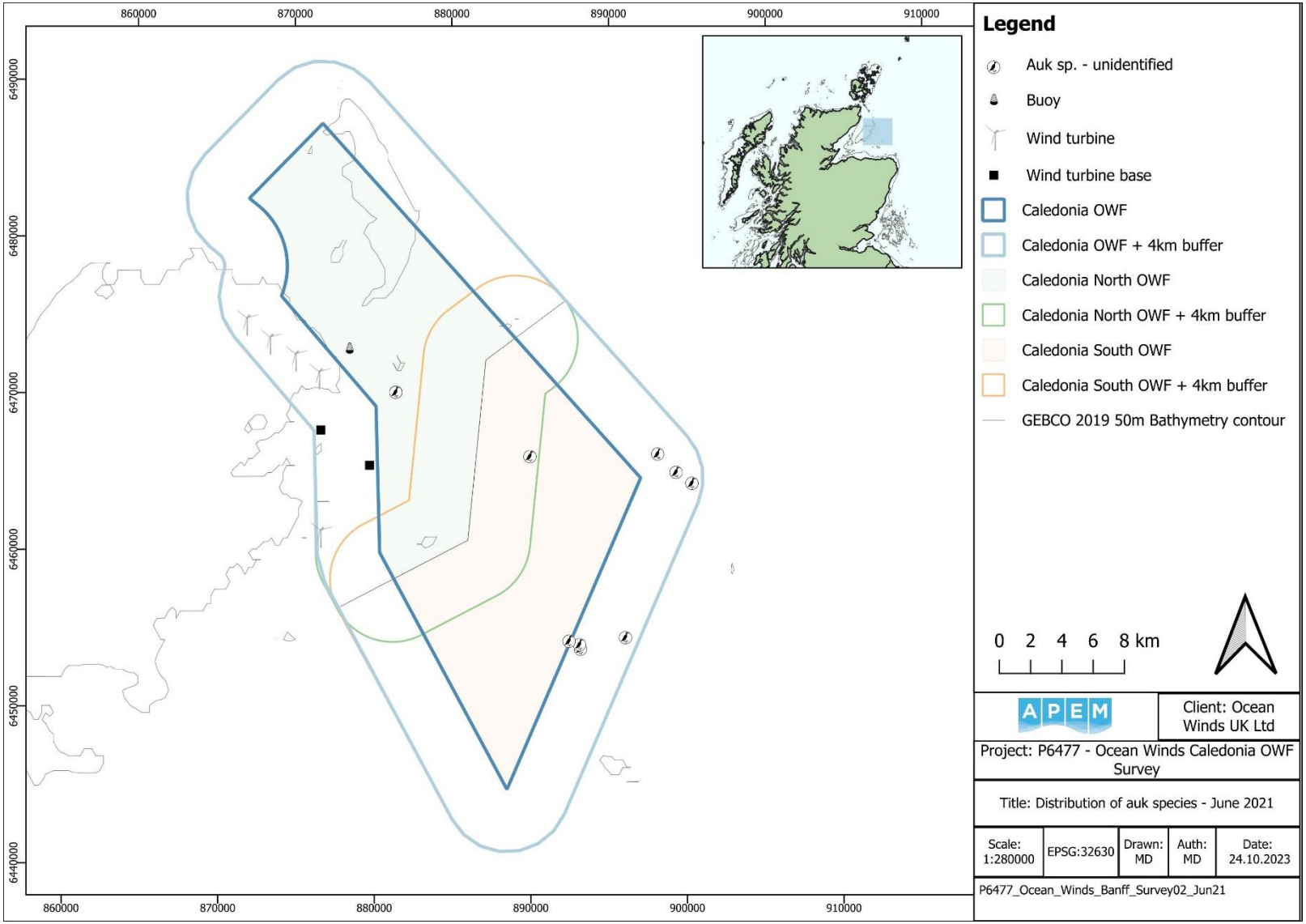



**Figure A4.238 Distribution of auk species recorded in the Survey Area in June 2021**

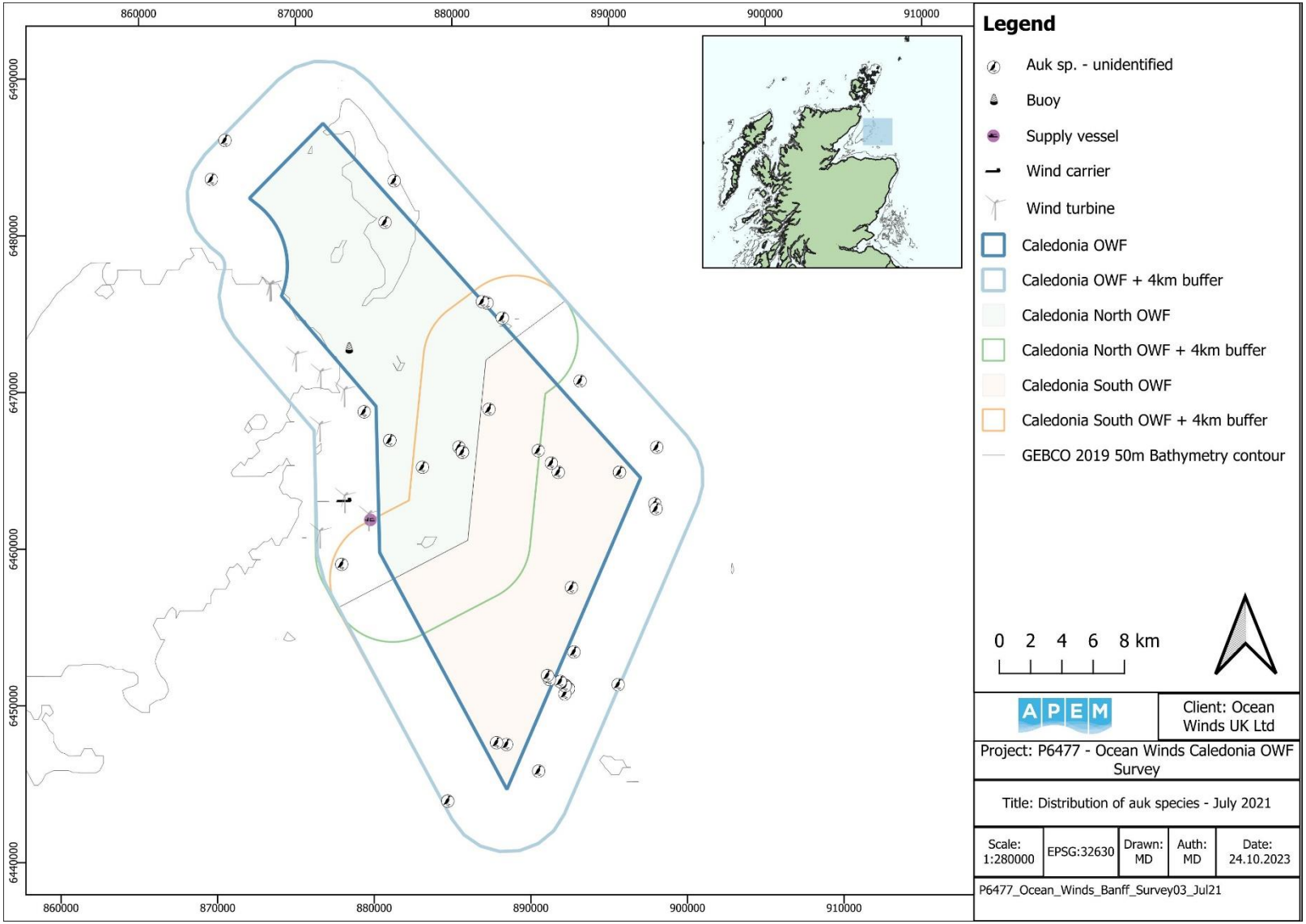



**Figure A4.239 Distribution of auk species recorded in the Survey Area in July 2021**

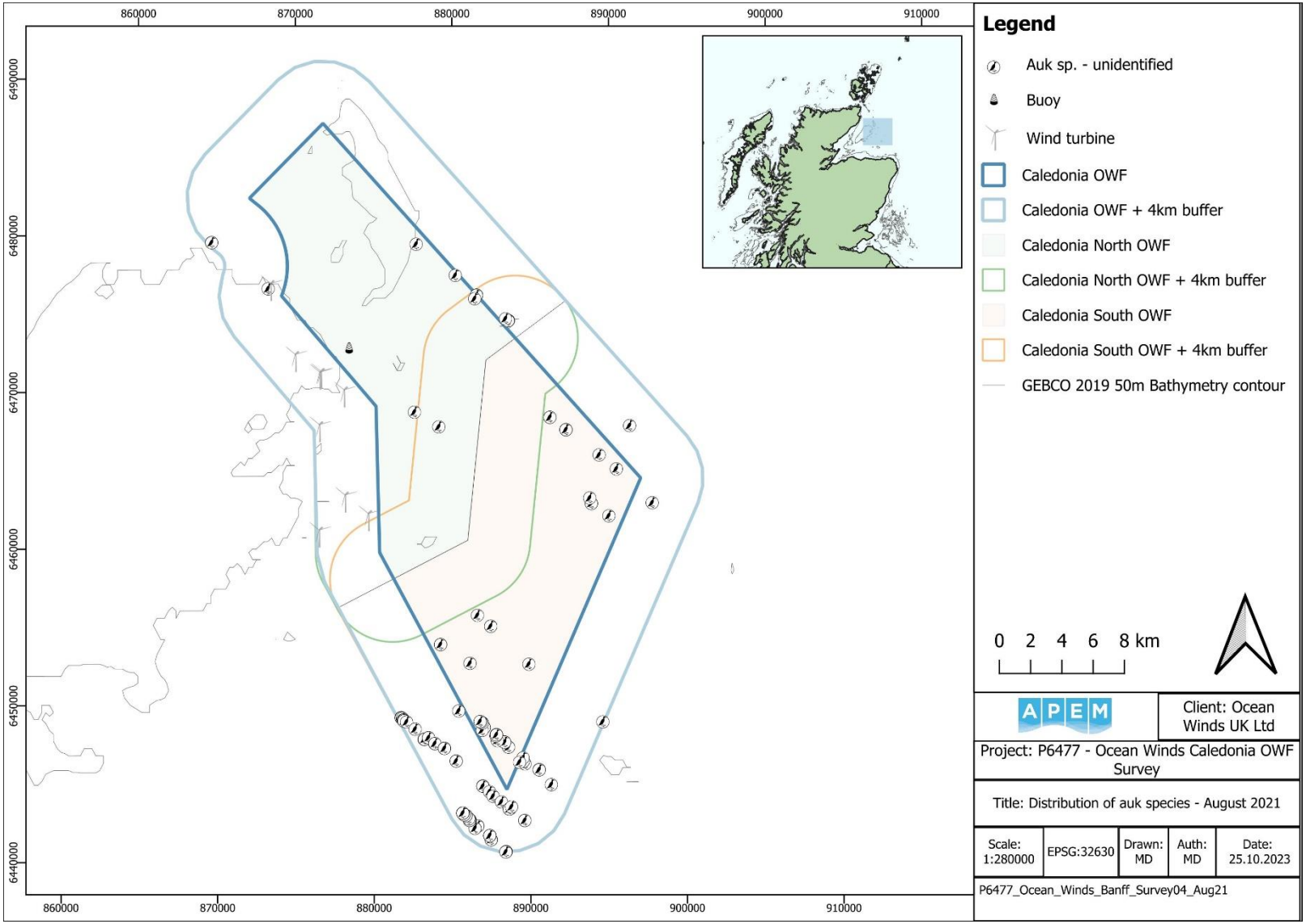



**Figure A4.240 Distribution of auk species recorded in the Survey Area in August 2021**

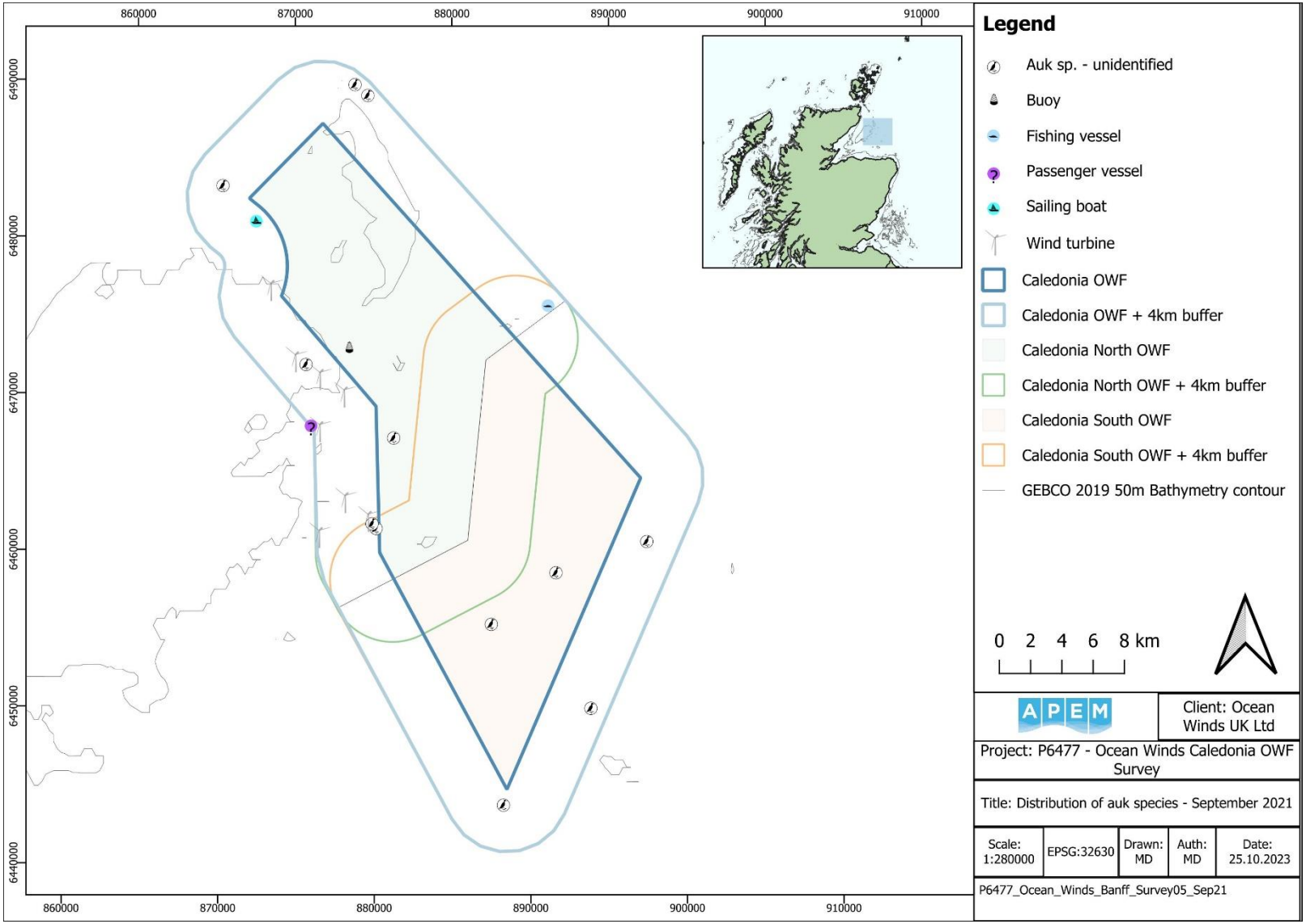



**Figure A4.241 Distribution of auk species recorded in the Survey Area in September 2021**

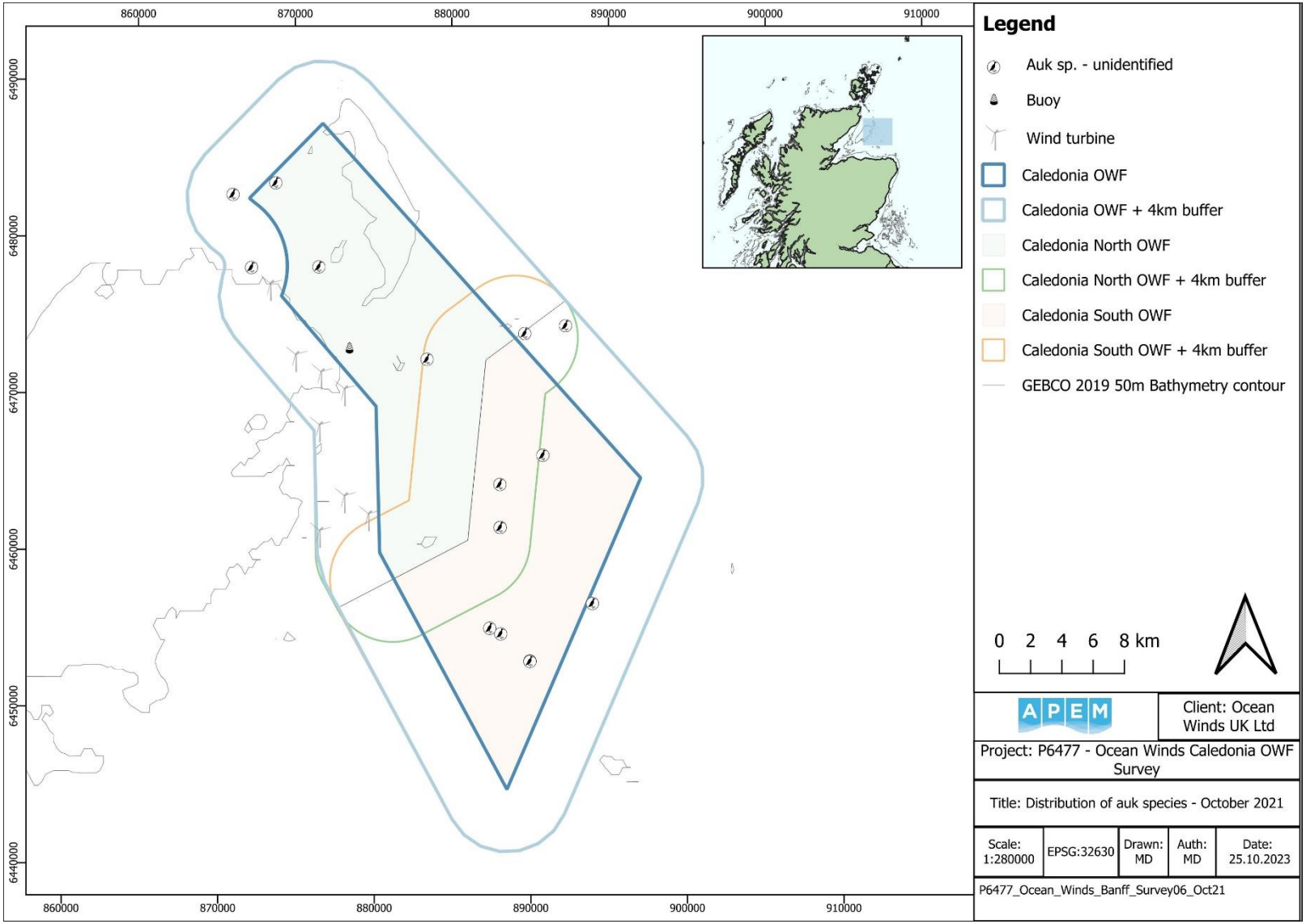



**Figure A4.242 Distribution of auk species recorded in the Survey Area in October 2021**

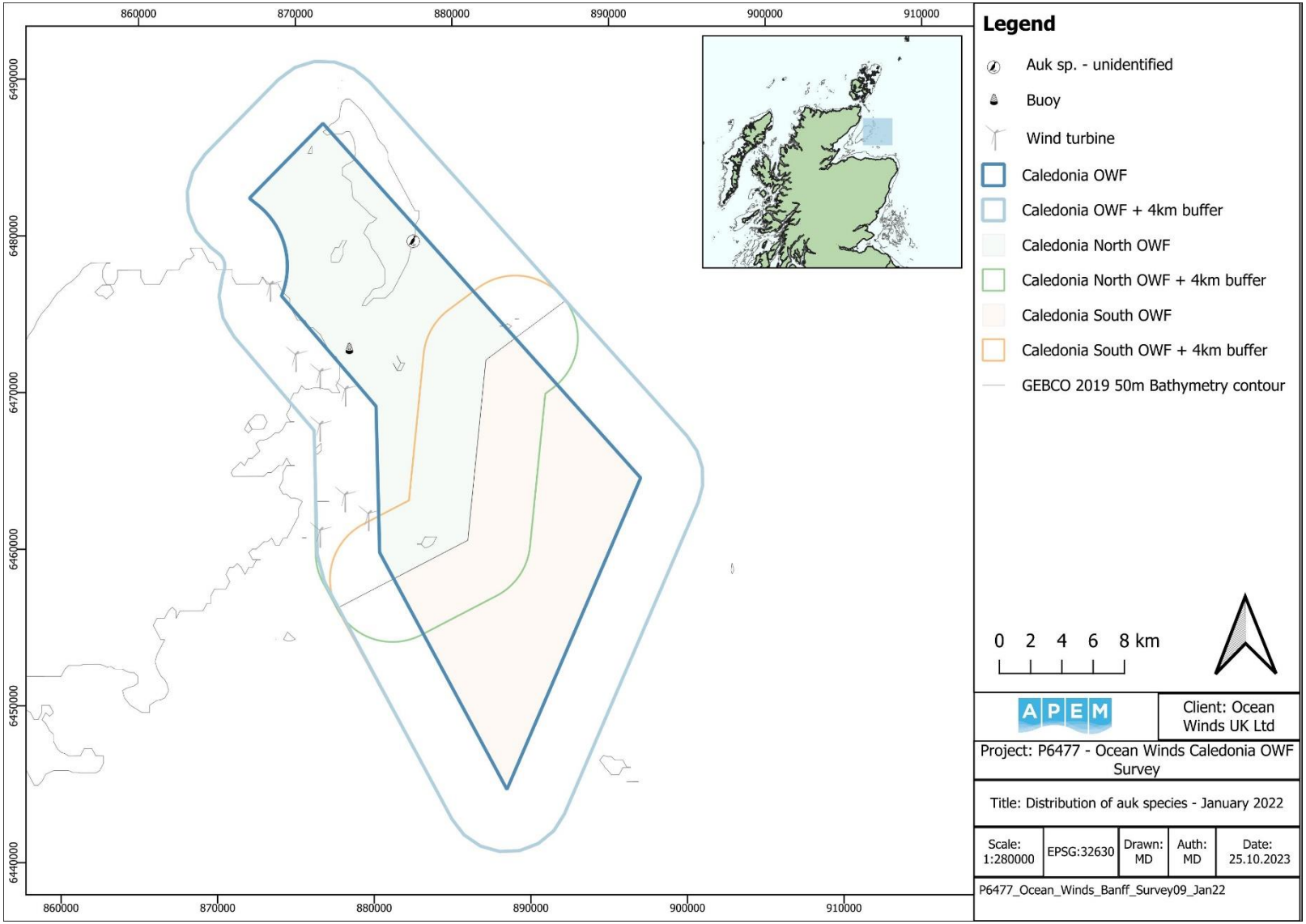



**Figure A4.243 Distribution of auk species recorded in the Survey Area in January 2022**

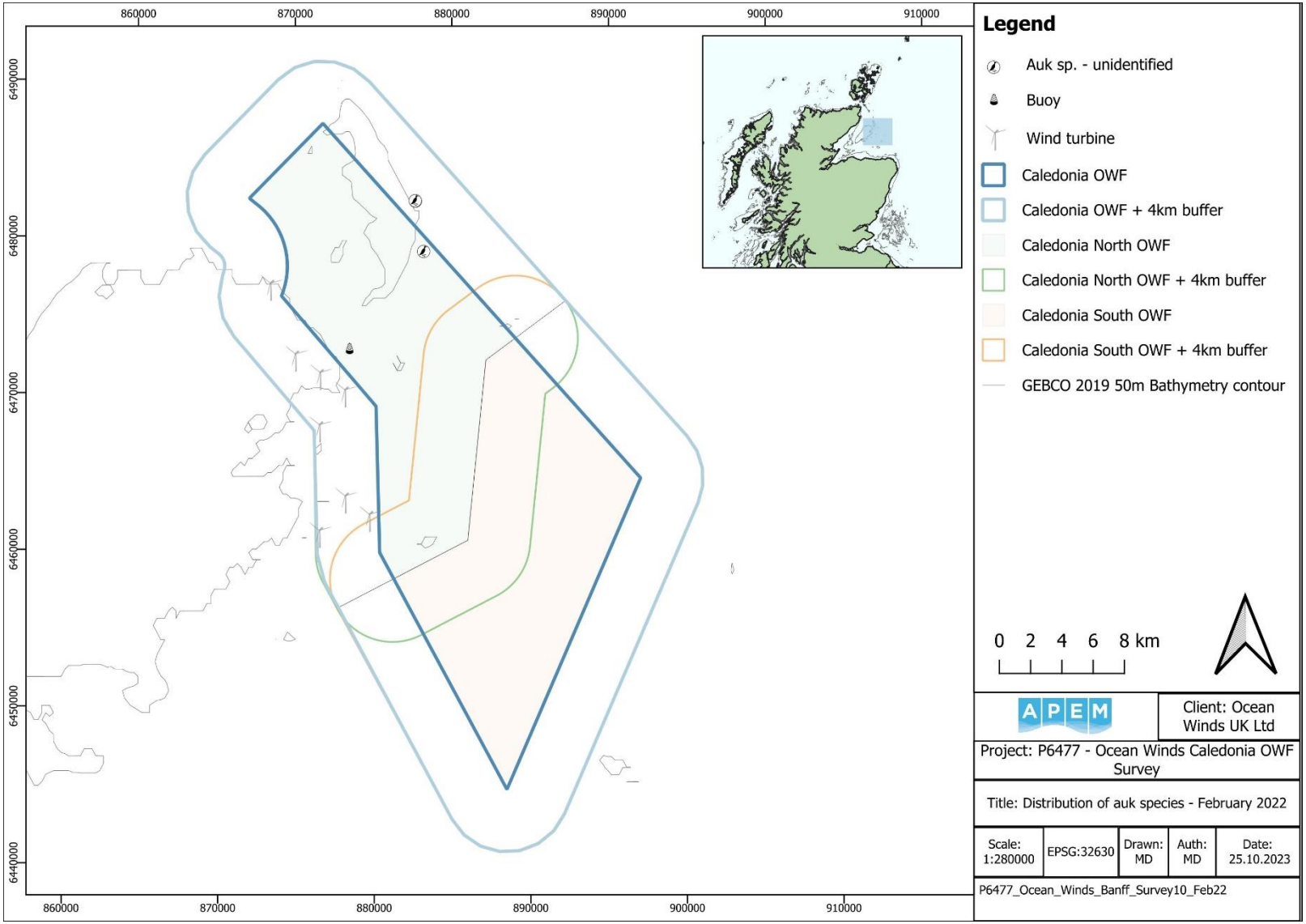



**Figure A4.244 Distribution of auk species recorded in the Survey Area in February 2022**

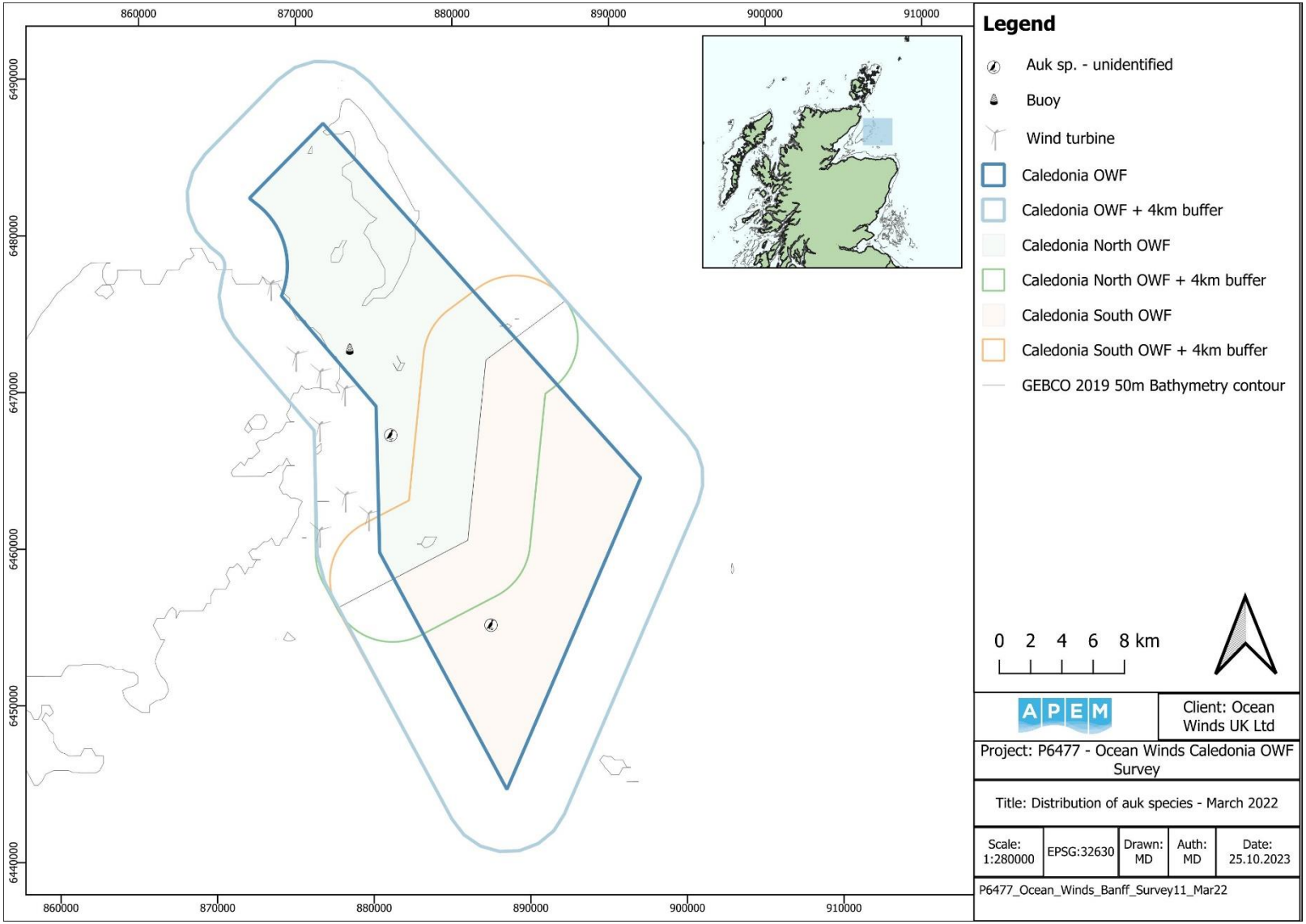



**Figure A4.245 Distribution of auk species recorded in the Survey Area in March 2022**

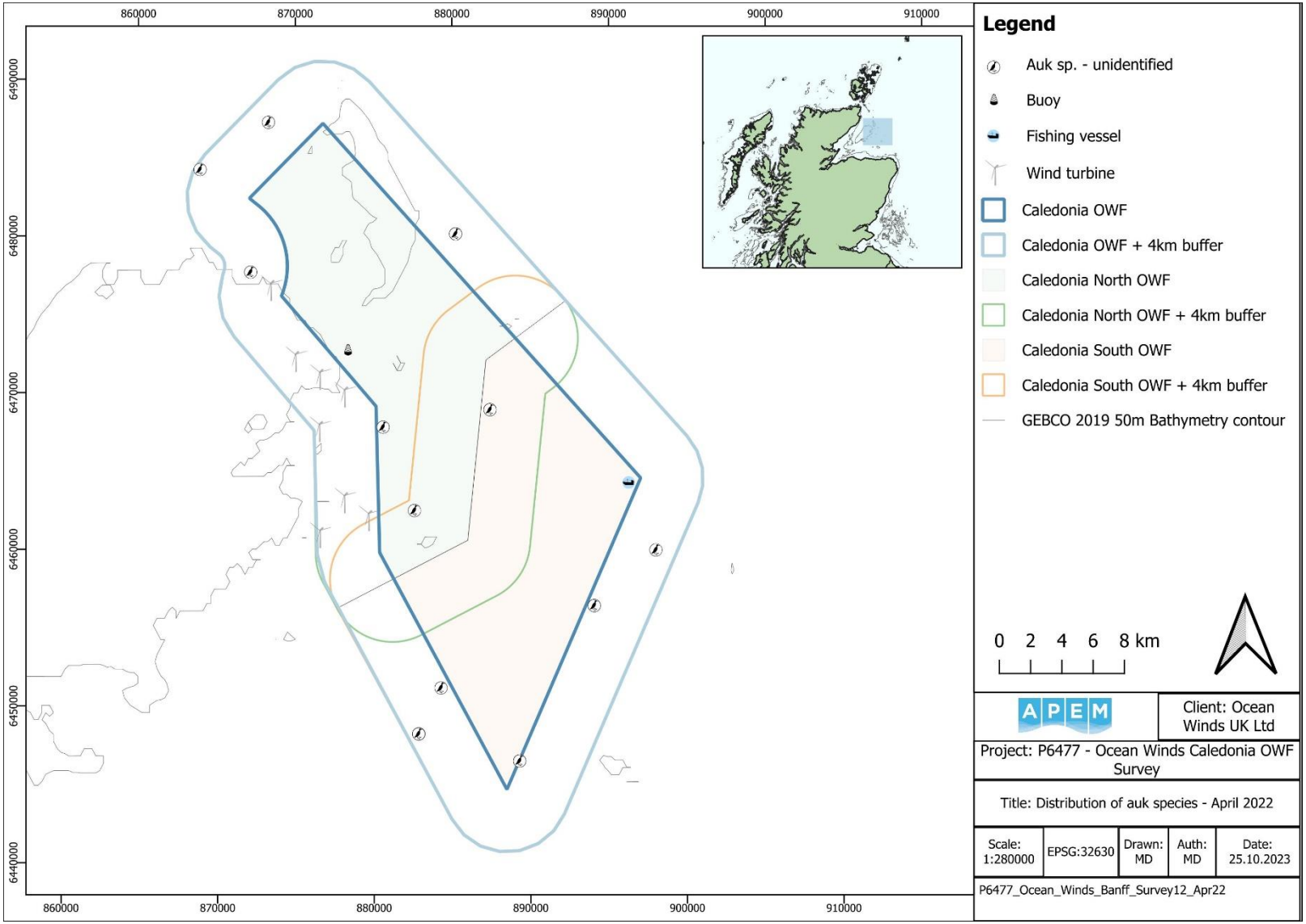



**Figure A4.246 Distribution of auk species recorded in the Survey Area in April 2022**

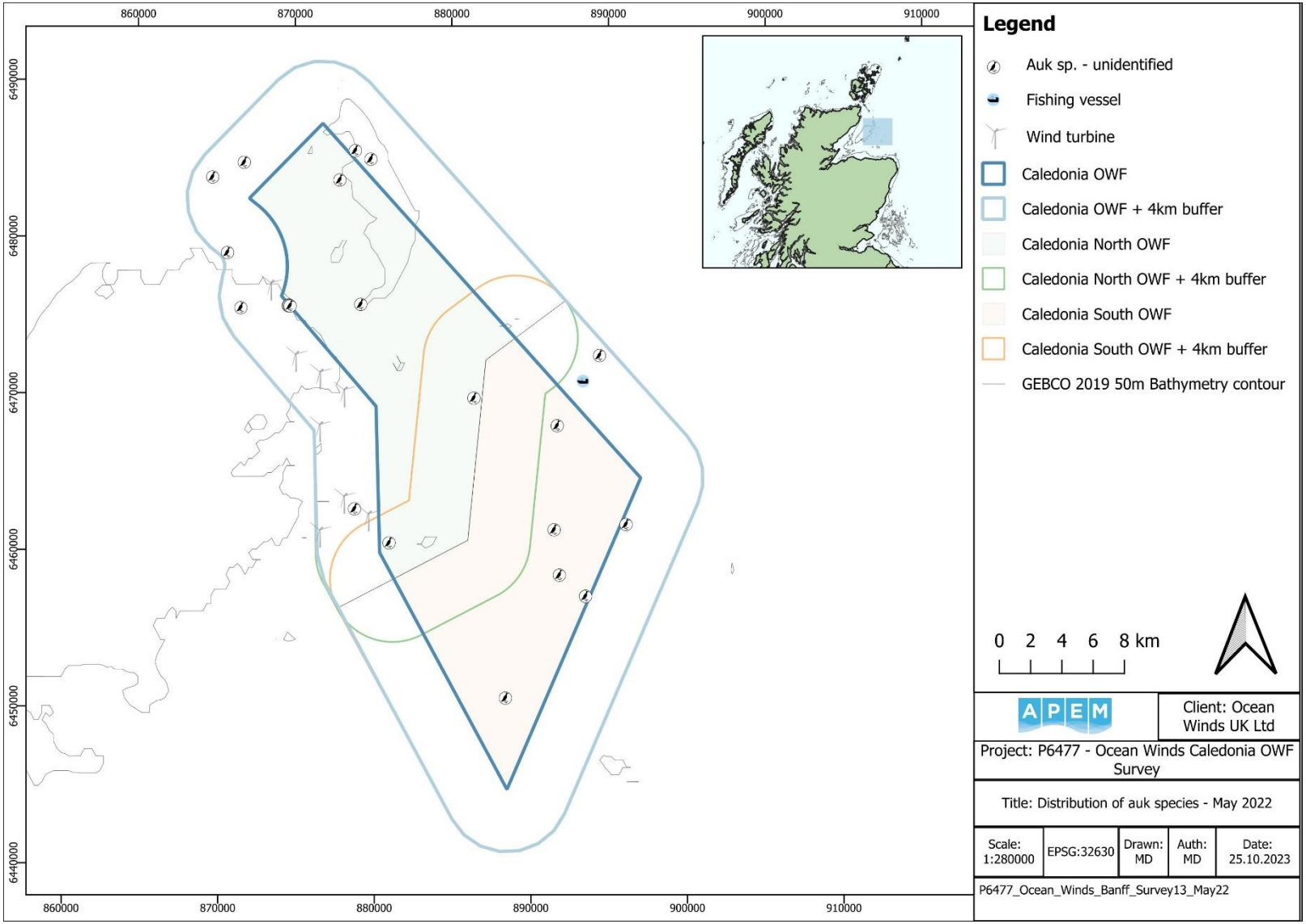



**Figure A4.247 Distribution of auk species recorded in the Survey Area in May 2022**

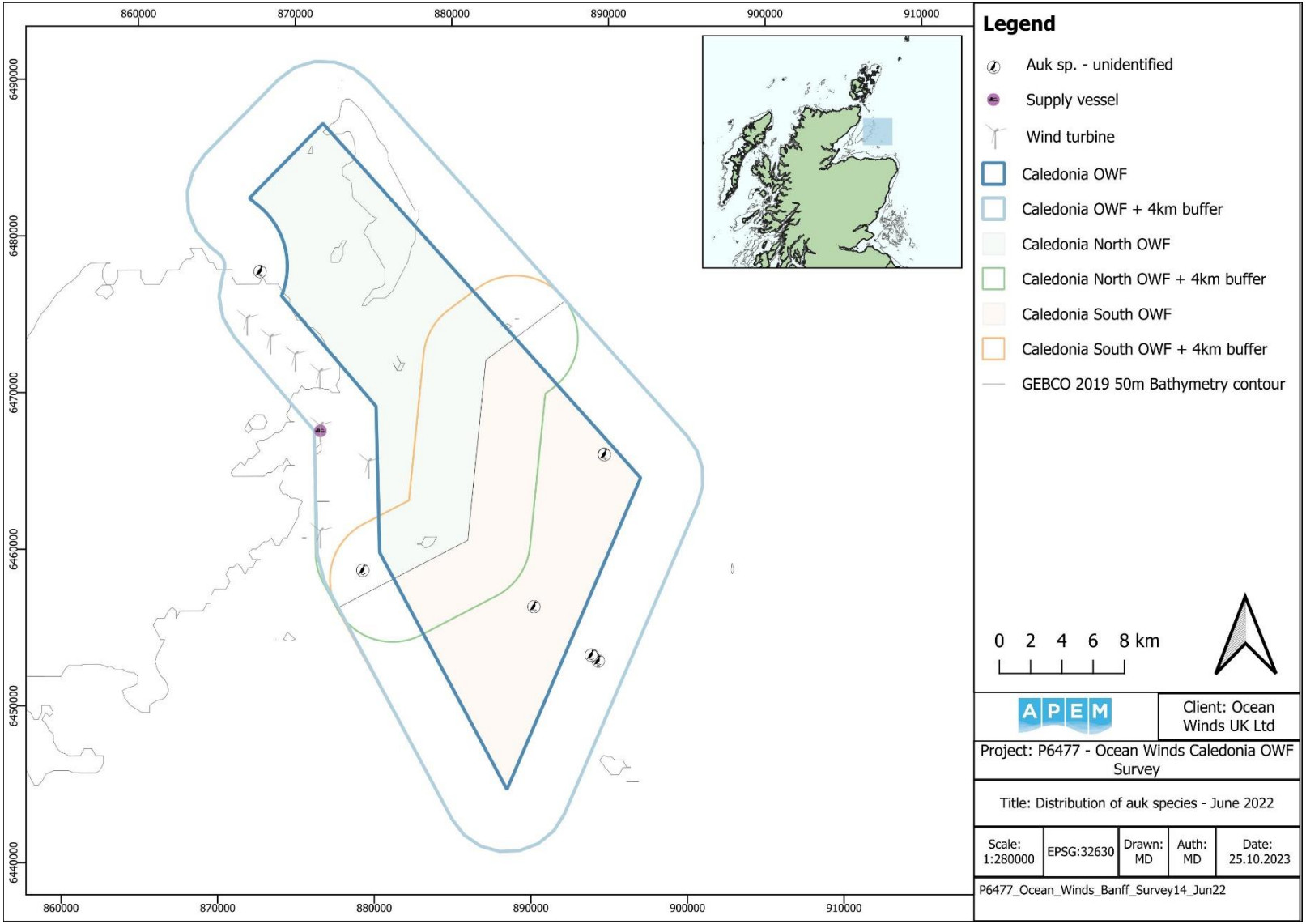



**Figure A4.248 Distribution of auk species recorded in the Survey Area in June 2022**

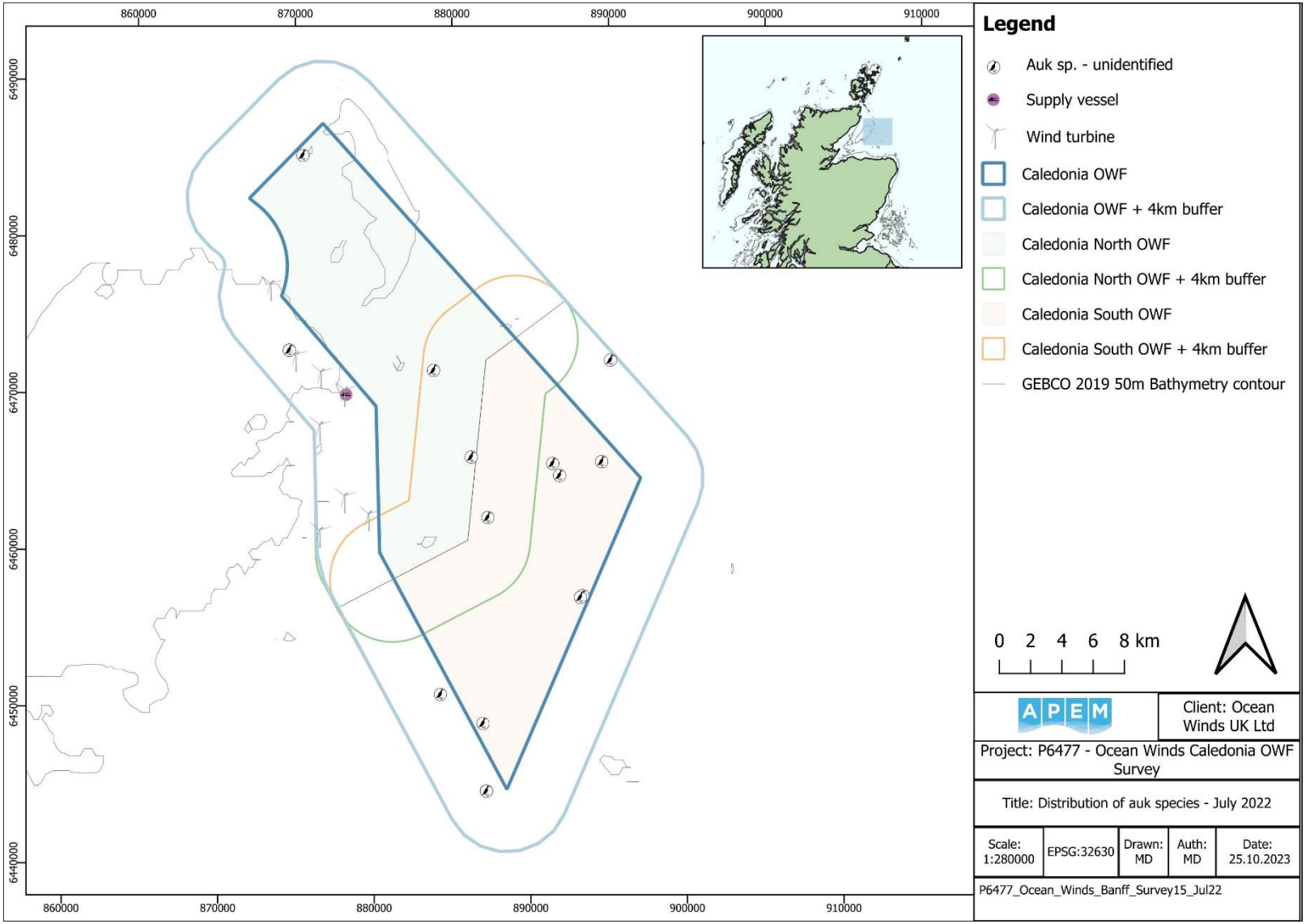



**Figure A4.249 Distribution of auk species recorded in the Survey Area in July 2022**

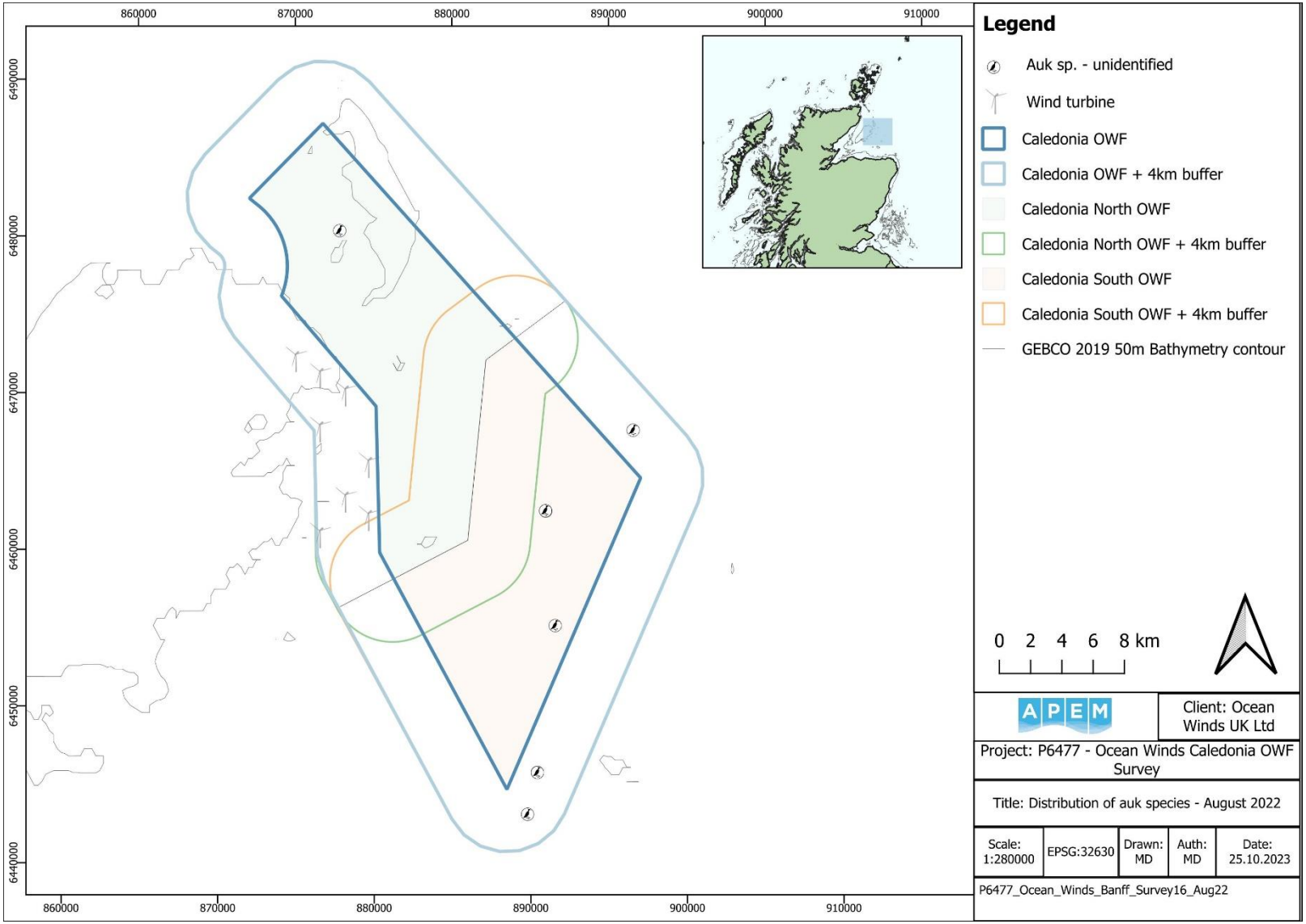



**Figure A4.250 Distribution of auk species recorded in the Survey Area in August 2022**

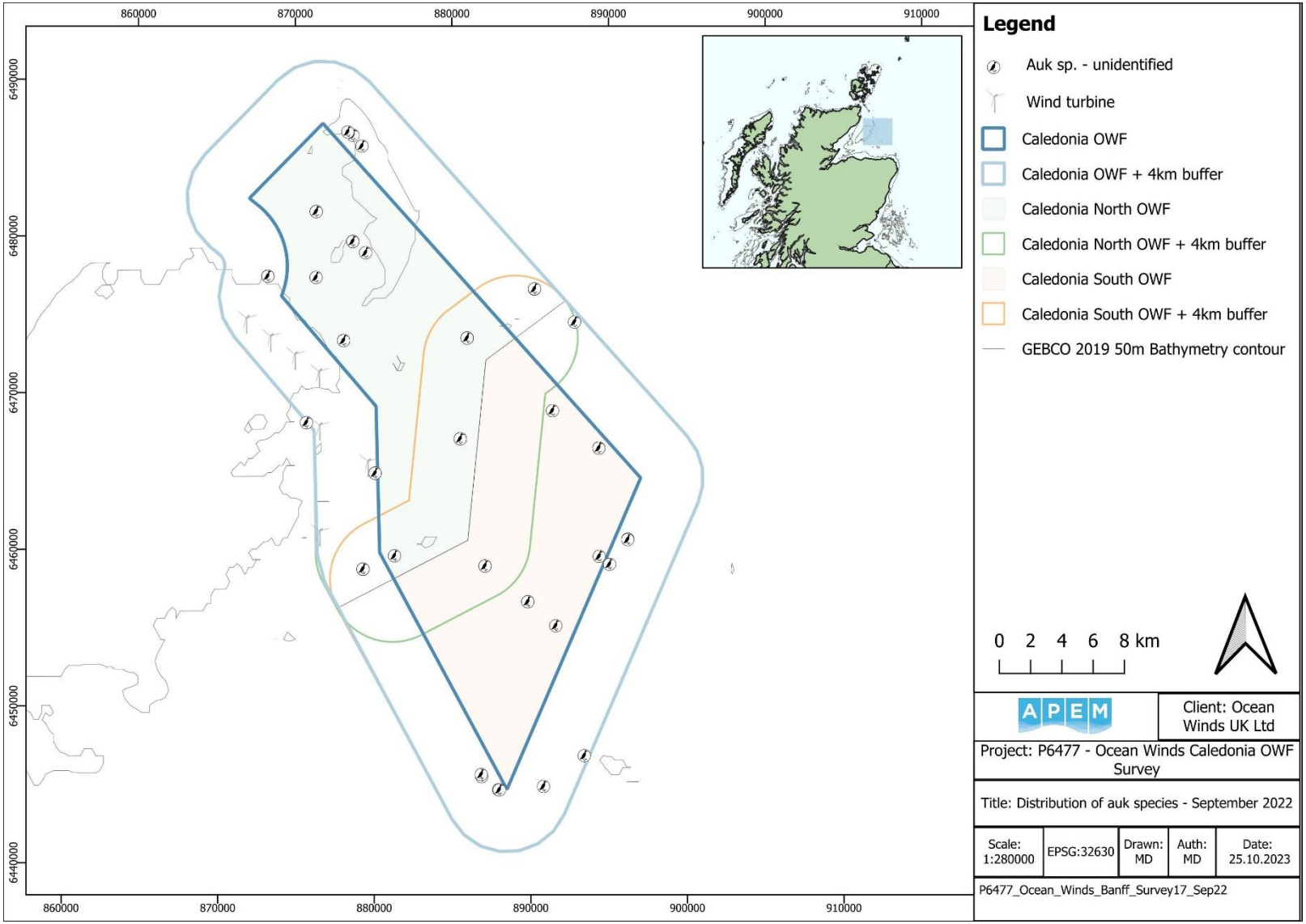



**Figure A4.251 Distribution of auk species recorded in the Survey Area in September 2022**

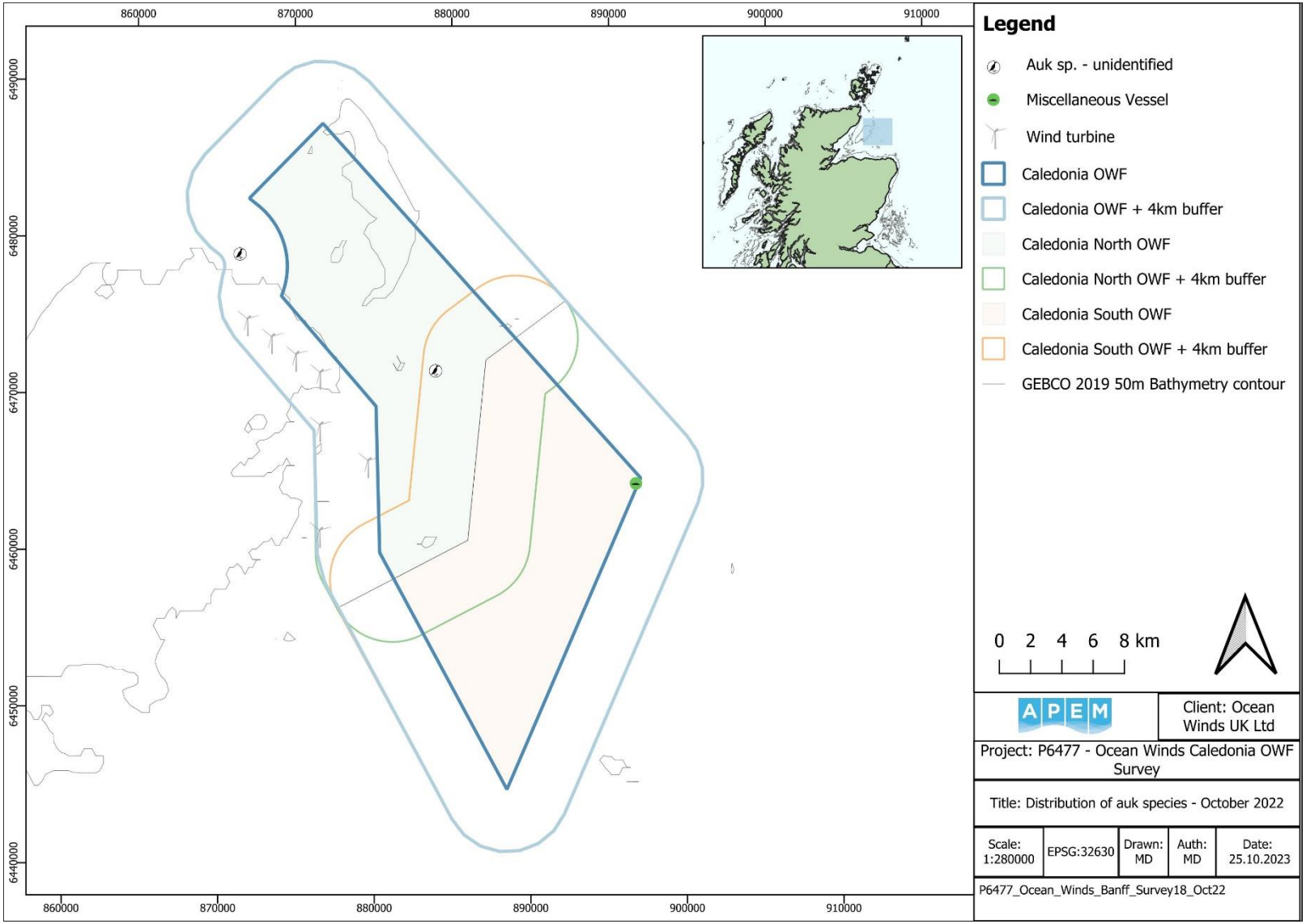



**Figure A4.252 Distribution of auk species recorded in the Survey Area in October 2022**

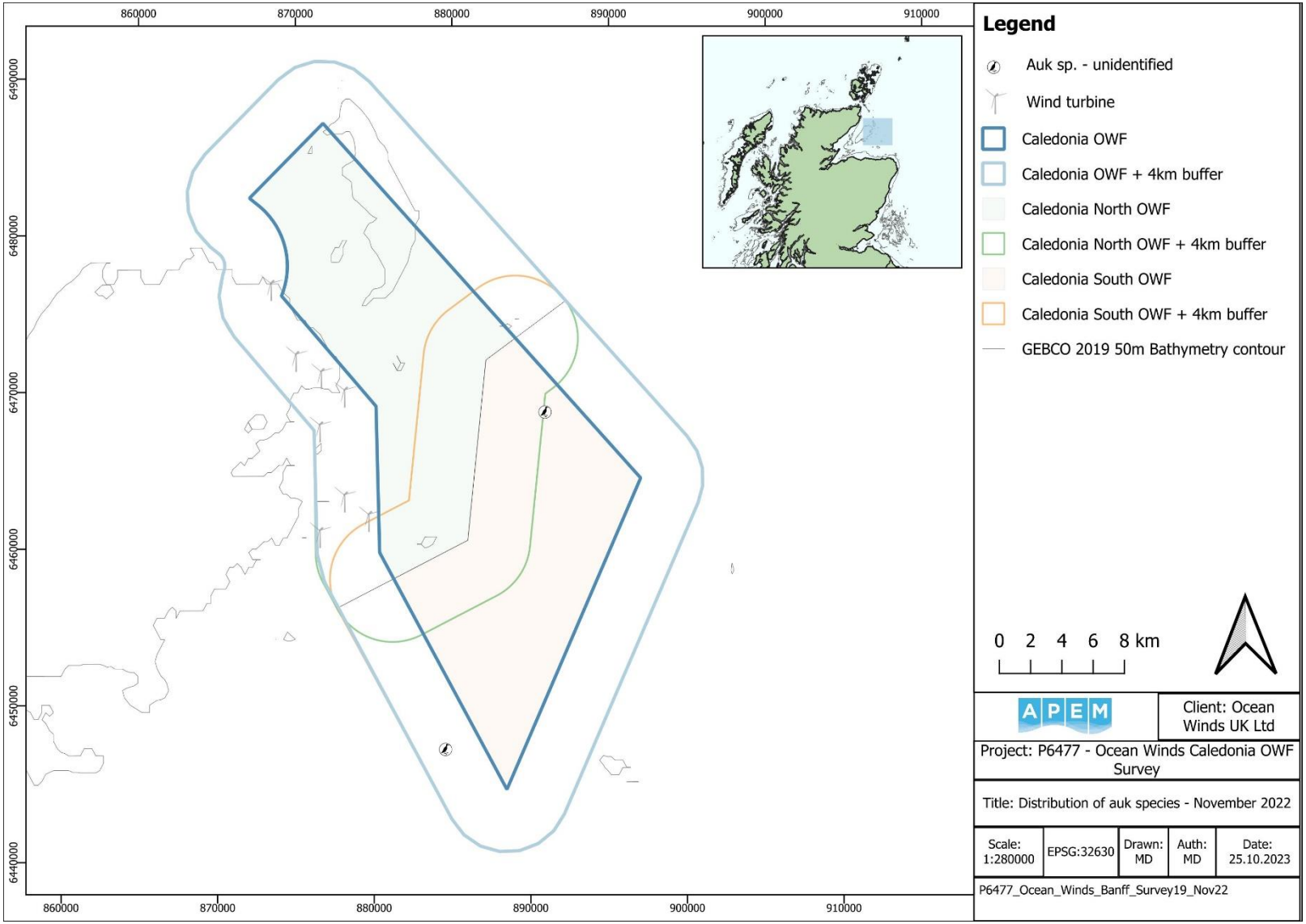



**Figure A4.253 Distribution of auk species recorded in the Survey Area in November 2022**

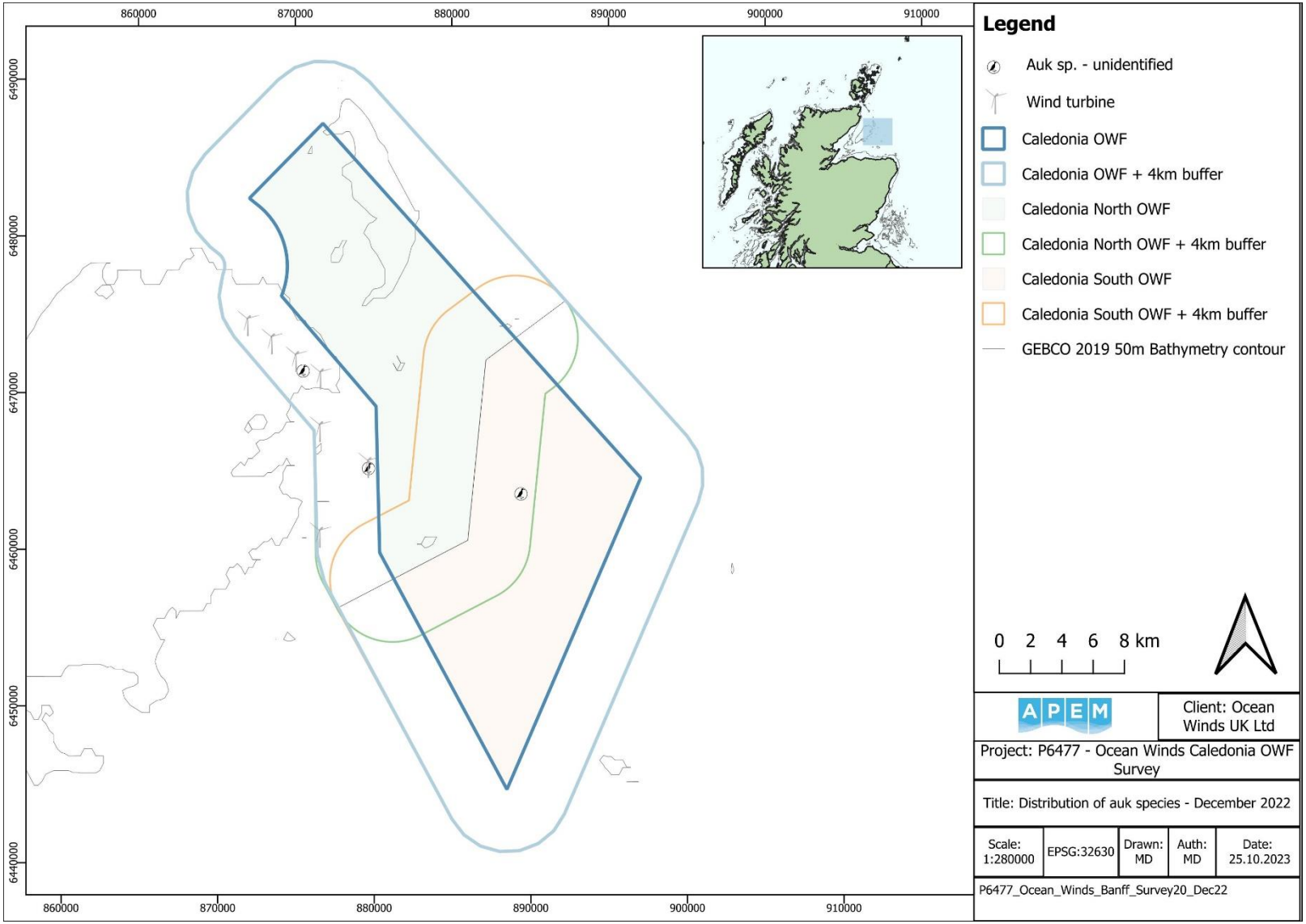



**Figure A4.254 Distribution of auk species recorded in the Survey Area in December 2022**

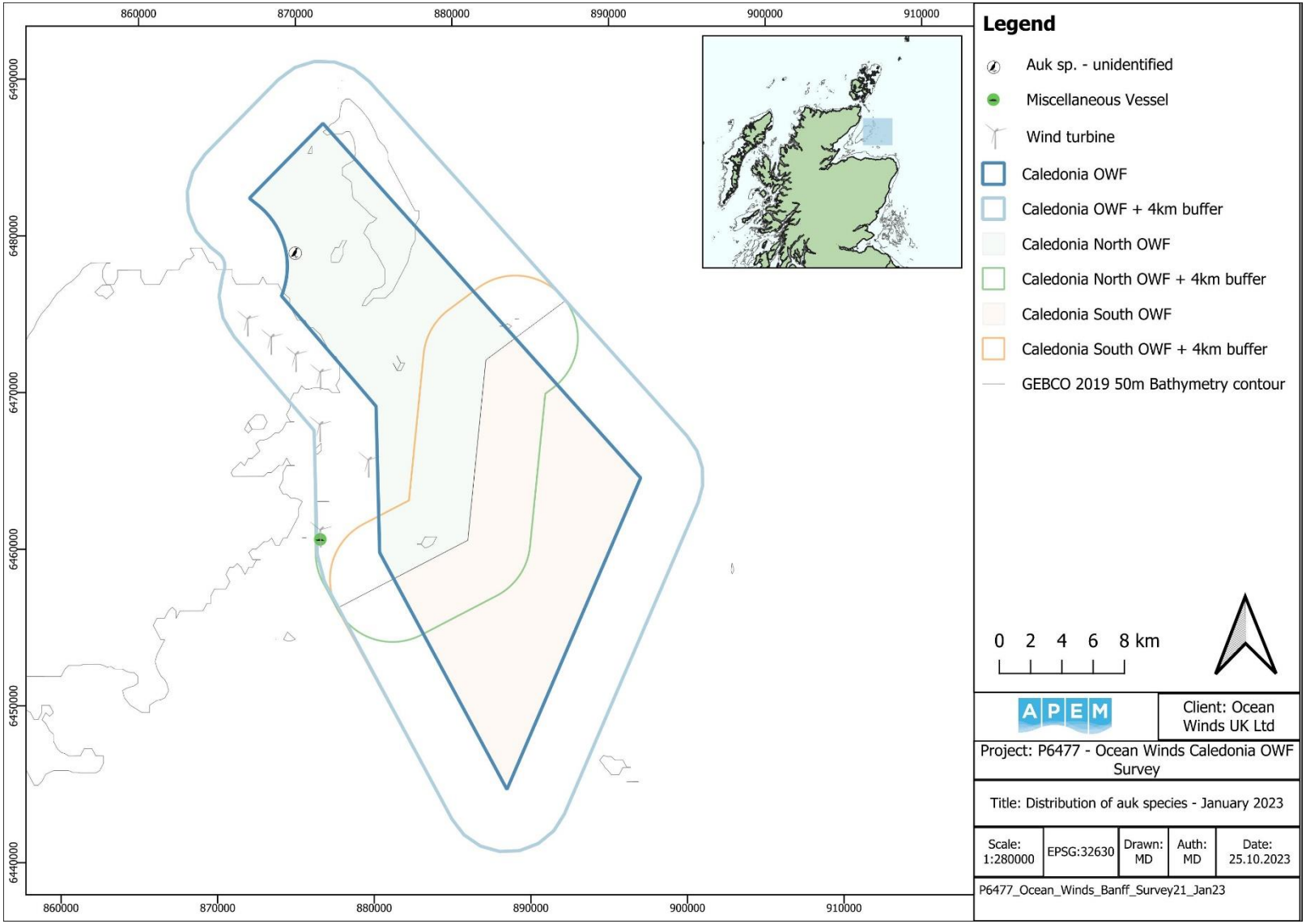



**Figure A4.255 Distribution of auk species recorded in the Survey Area in January 2023**

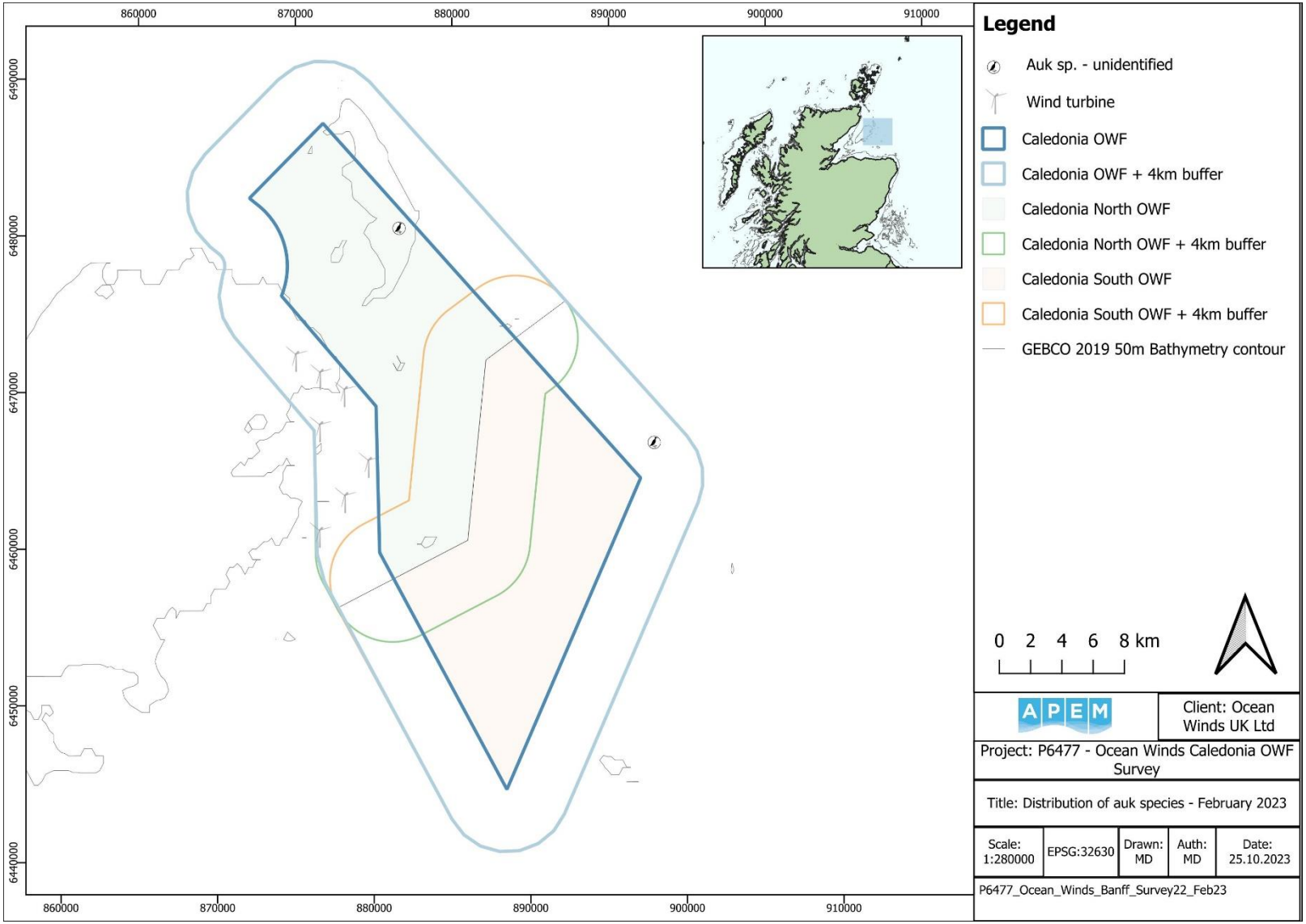



**Figure A4.256 Distribution of auk species recorded in the Survey Area in February 2023**

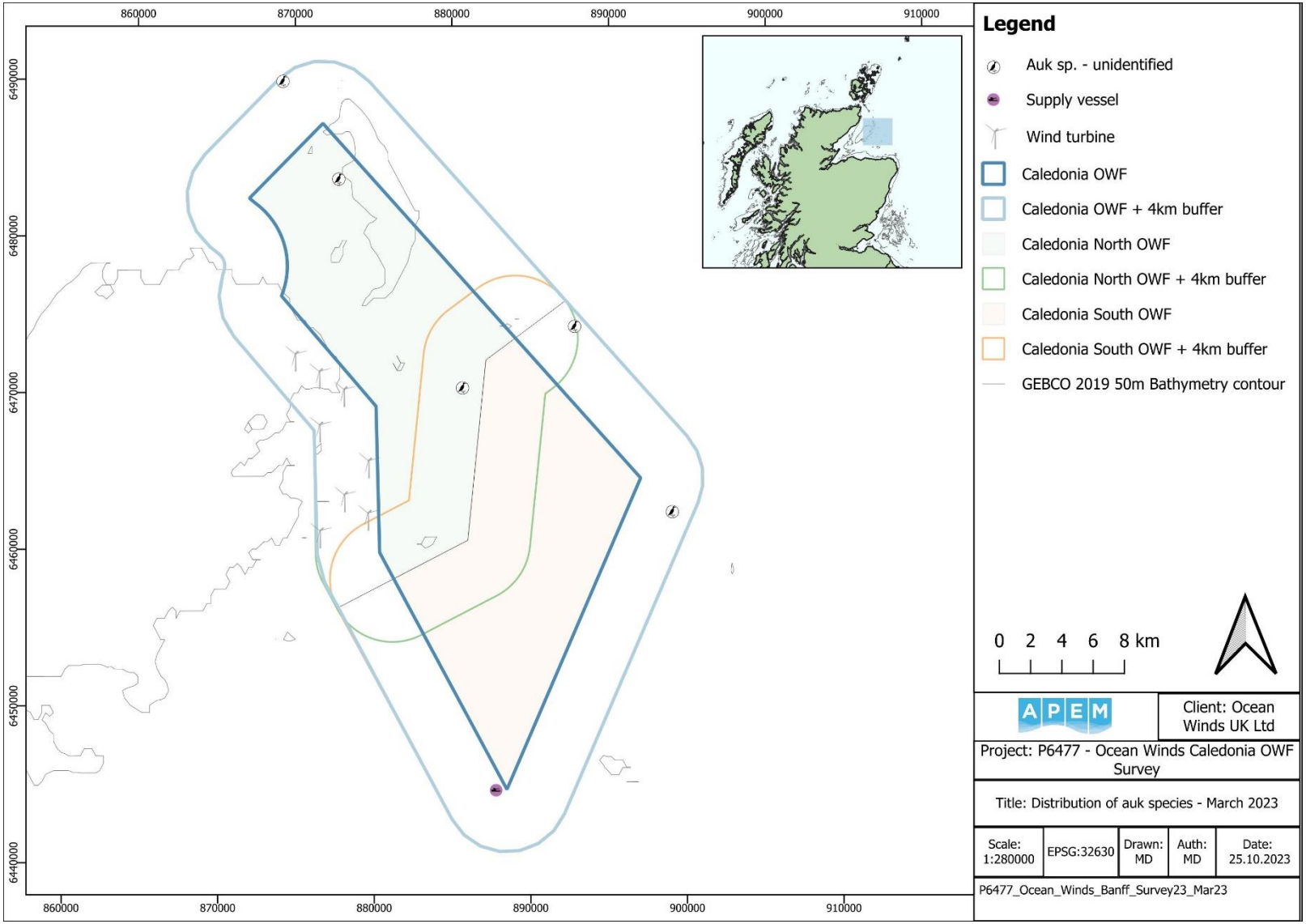



**Figure A4.257 Distribution of auk species recorded in the Survey Area in March 2023**

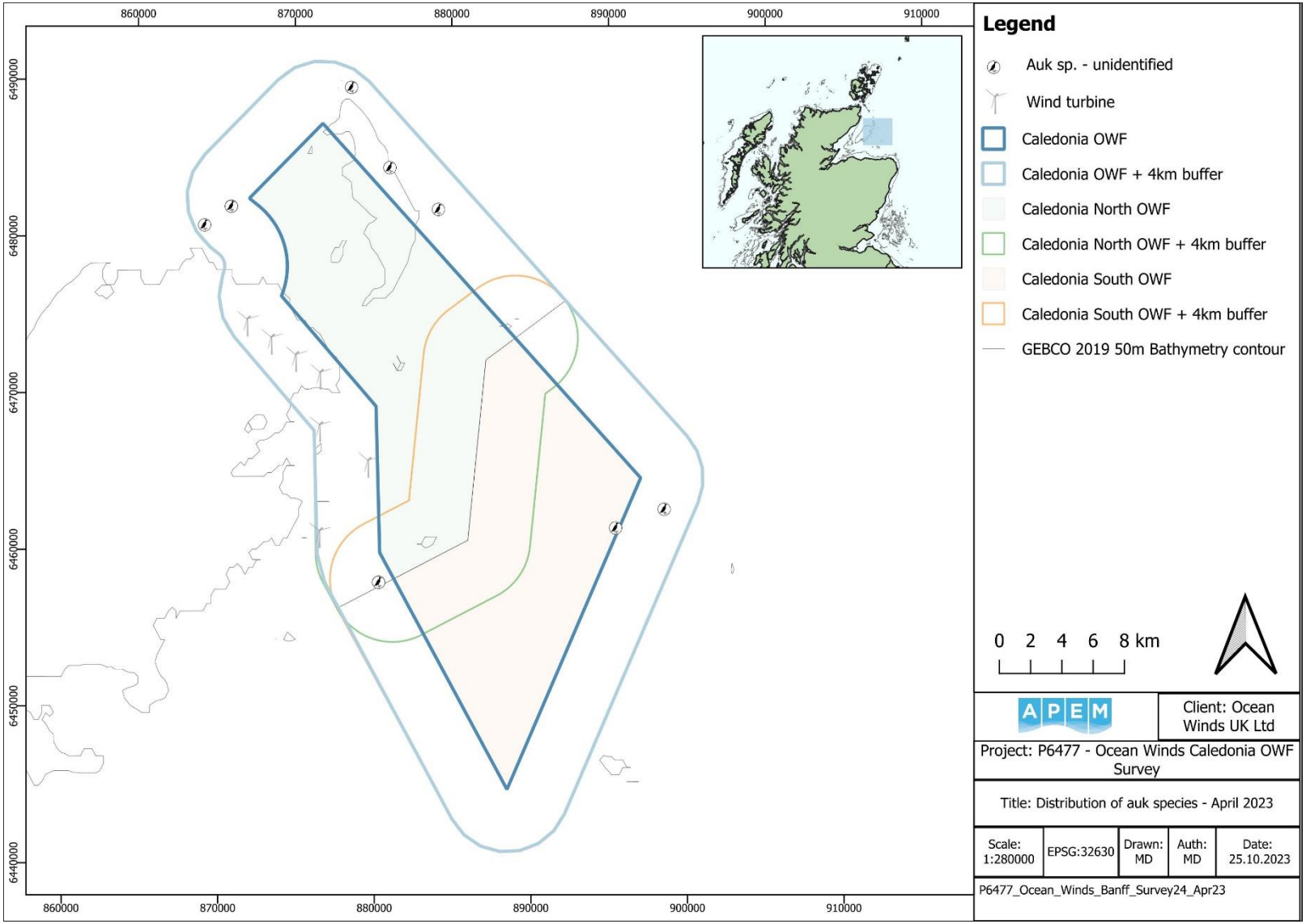



**Figure A4.258 Distribution of auk species recorded in the Survey Area in April 2023**

## Great northern diver

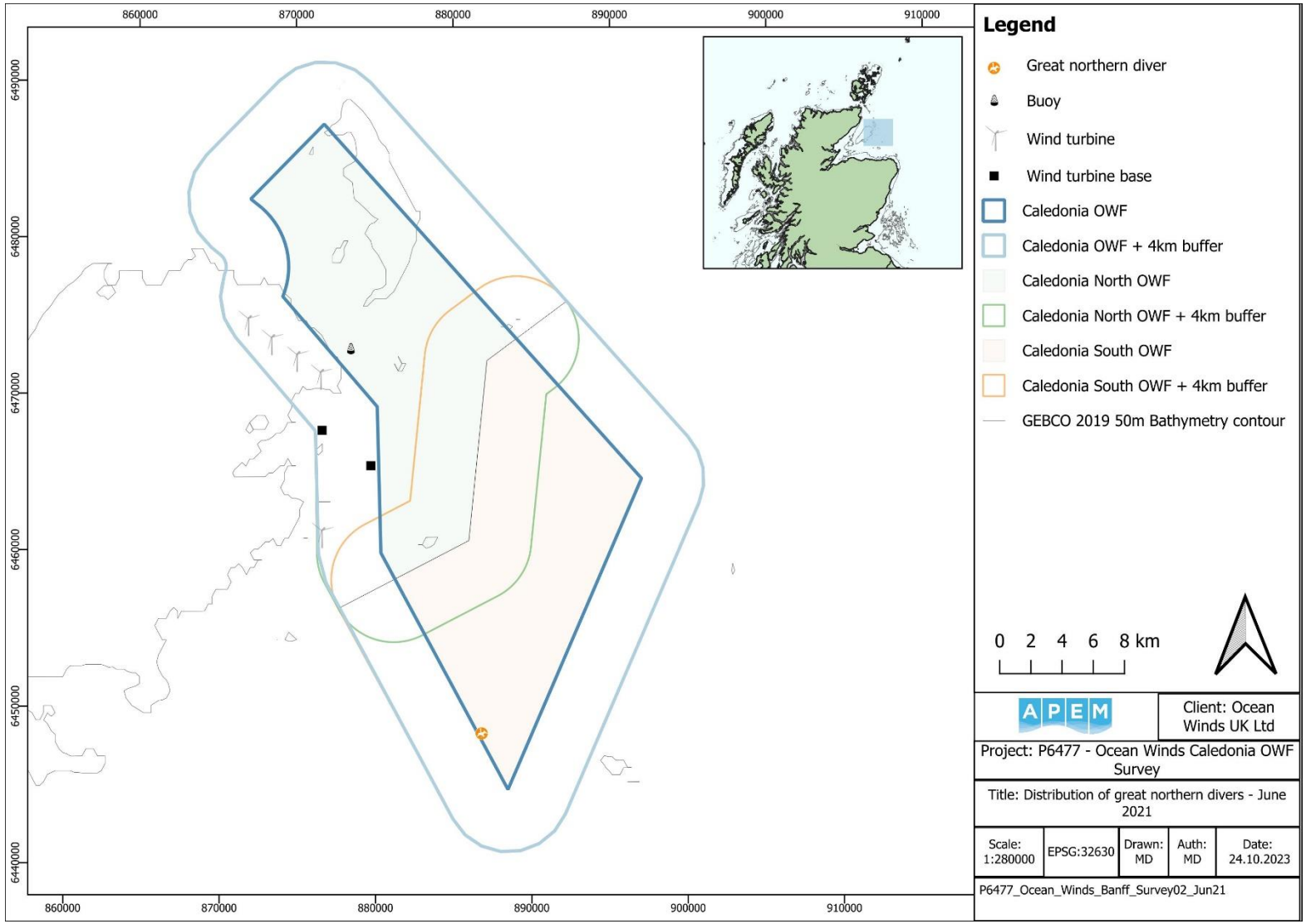



**Figure A4.259 Distribution of great northern divers recorded in the Survey Area in June 2021**

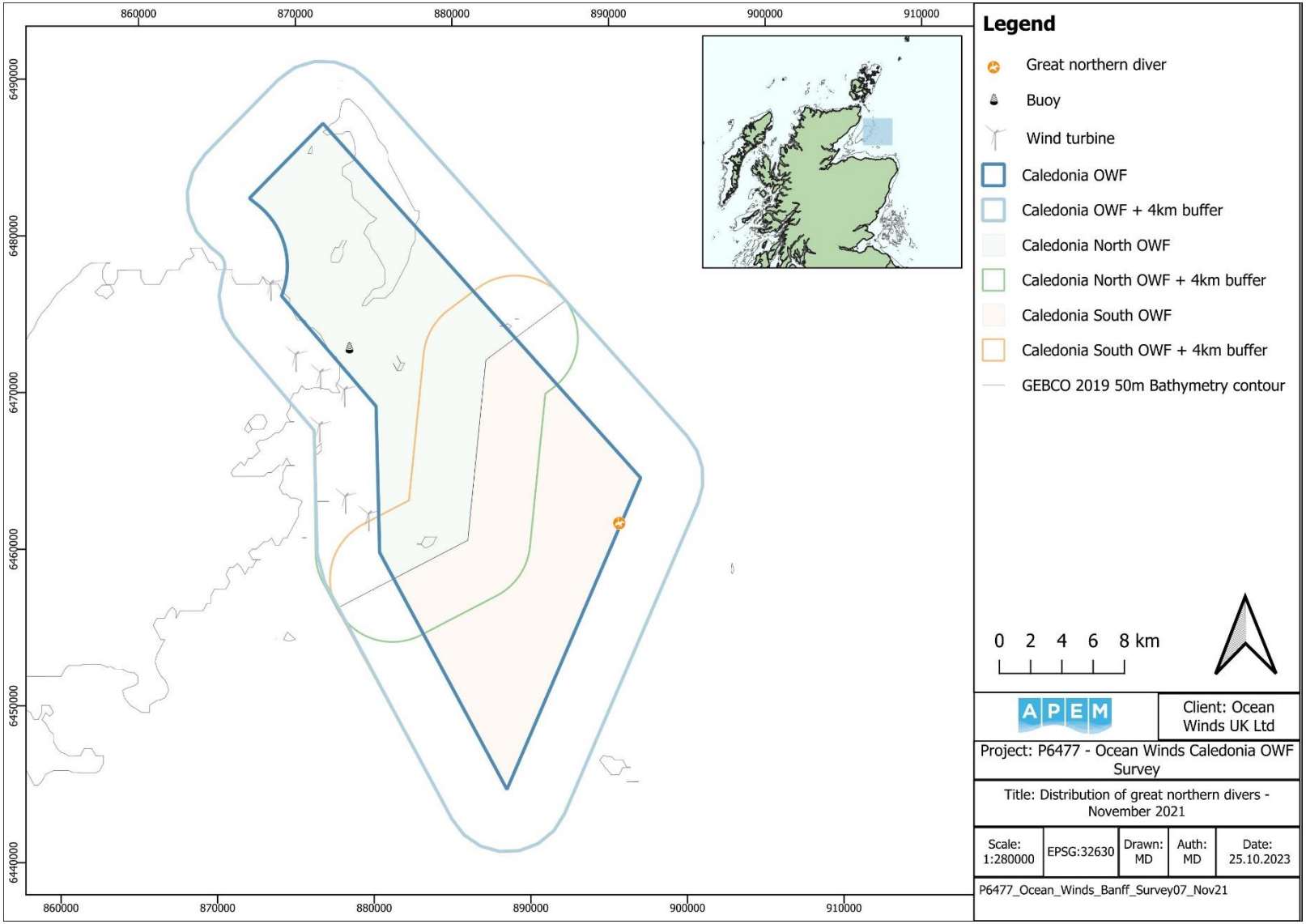



**Figure A4.260 Distribution of great northern divers recorded in the Survey Area in November 2021**

## Red-throated diver

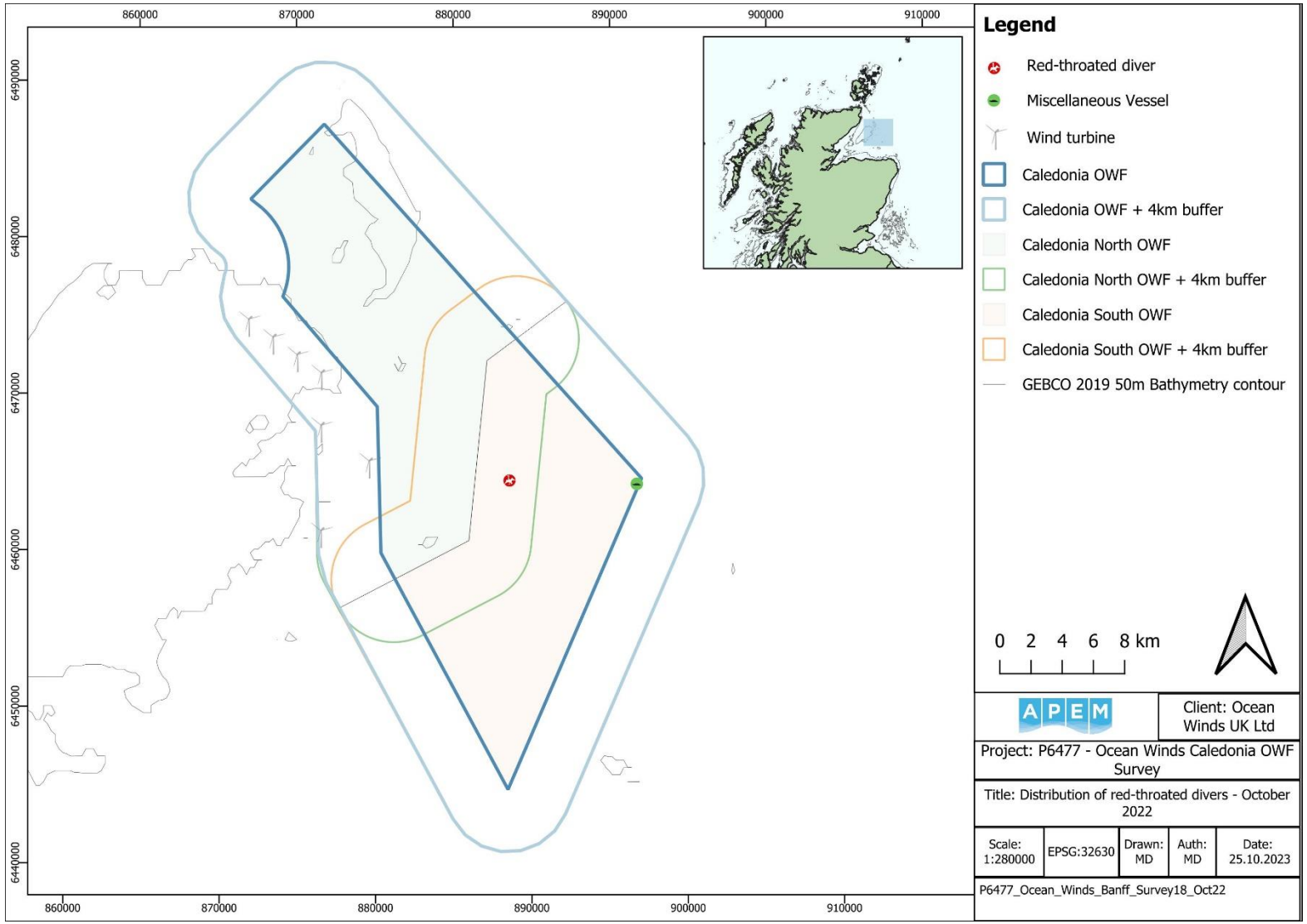



**Figure A4.261 Distribution of red-throated divers recorded in the Survey Area in October 2022**

## Fulmar

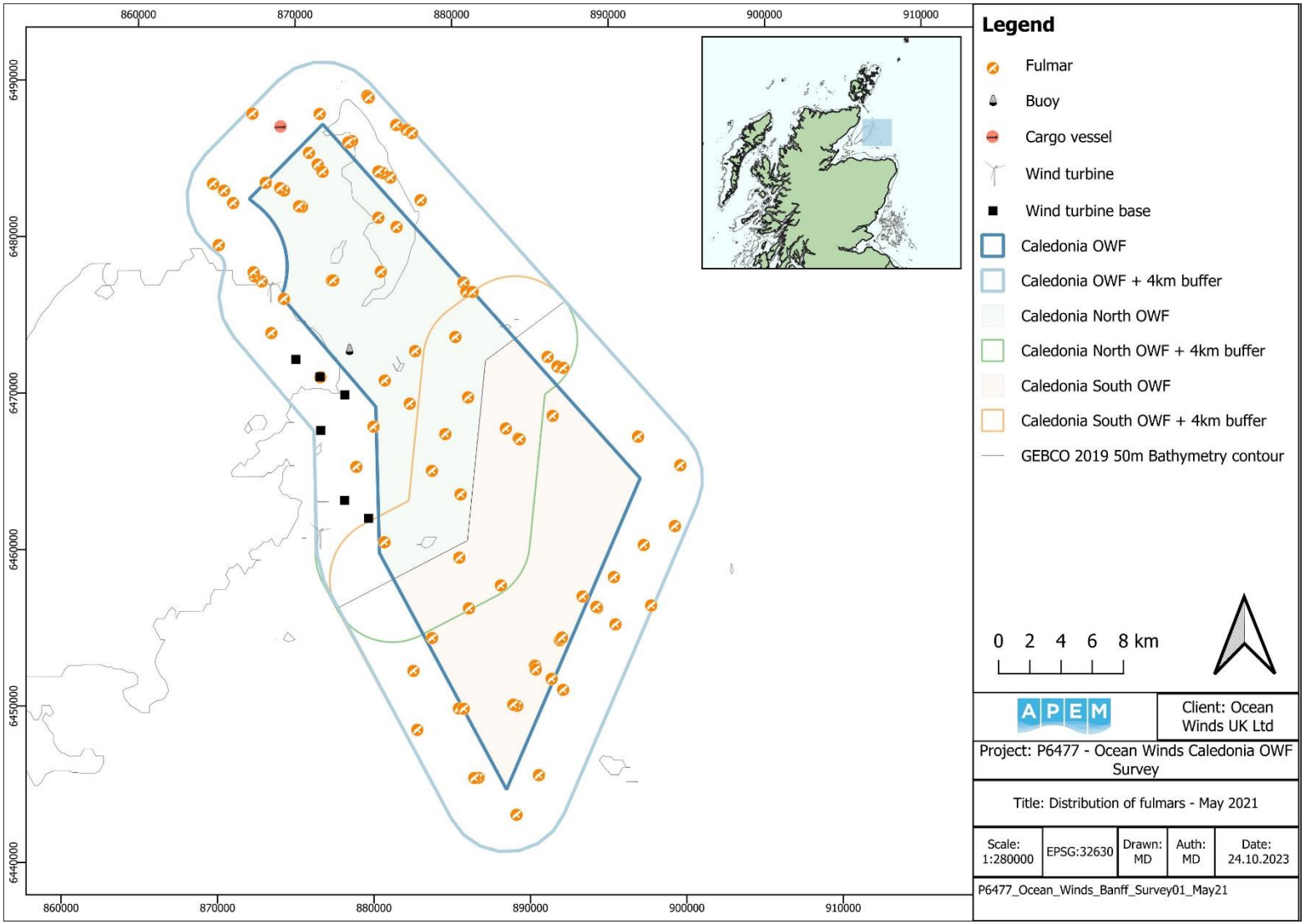



**Figure A4.262 Distribution of fulmars recorded in the Survey Area in May 2021**

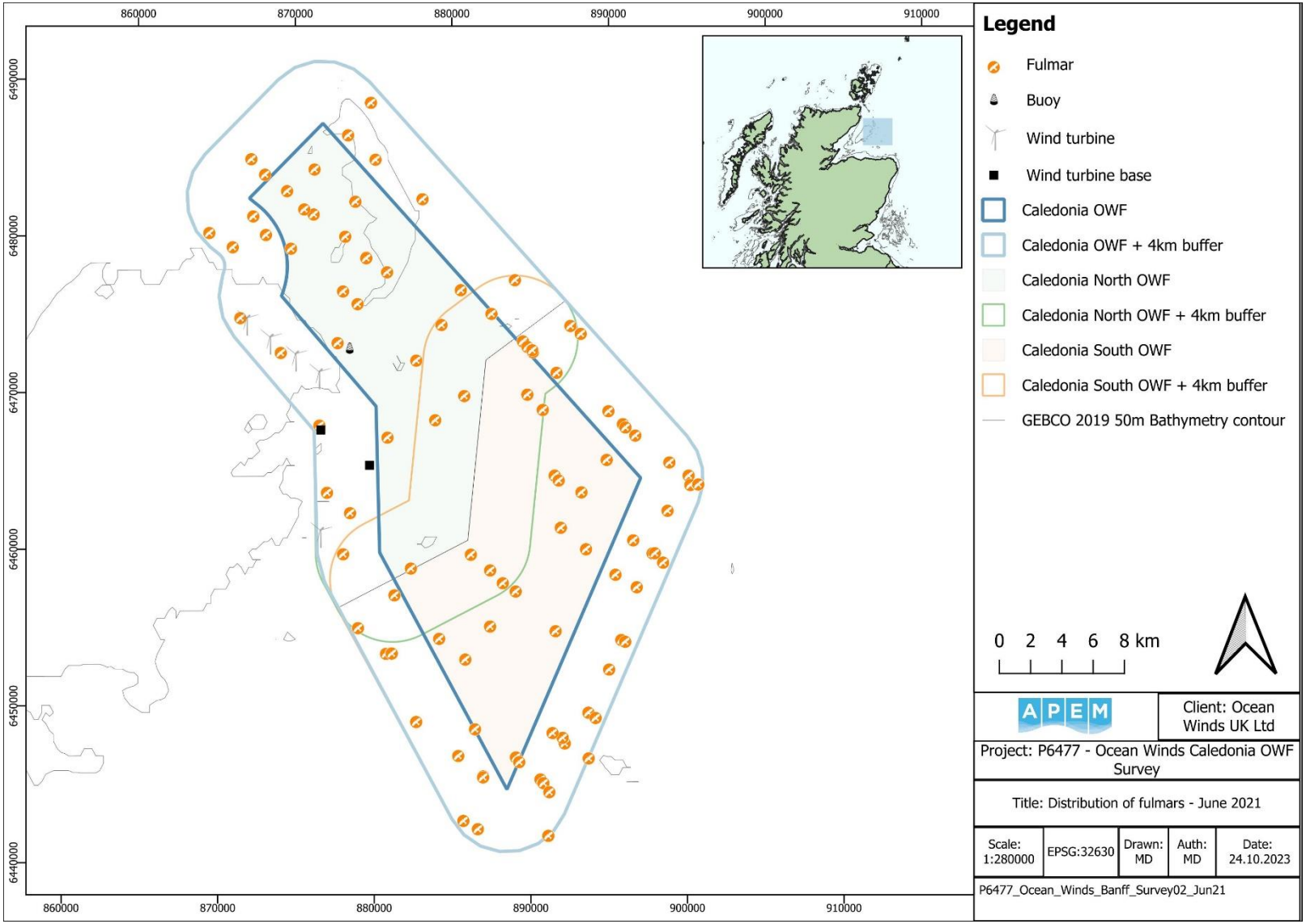



**Figure A4.263 Distribution of fulmars recorded in the Survey Area in June 2021**

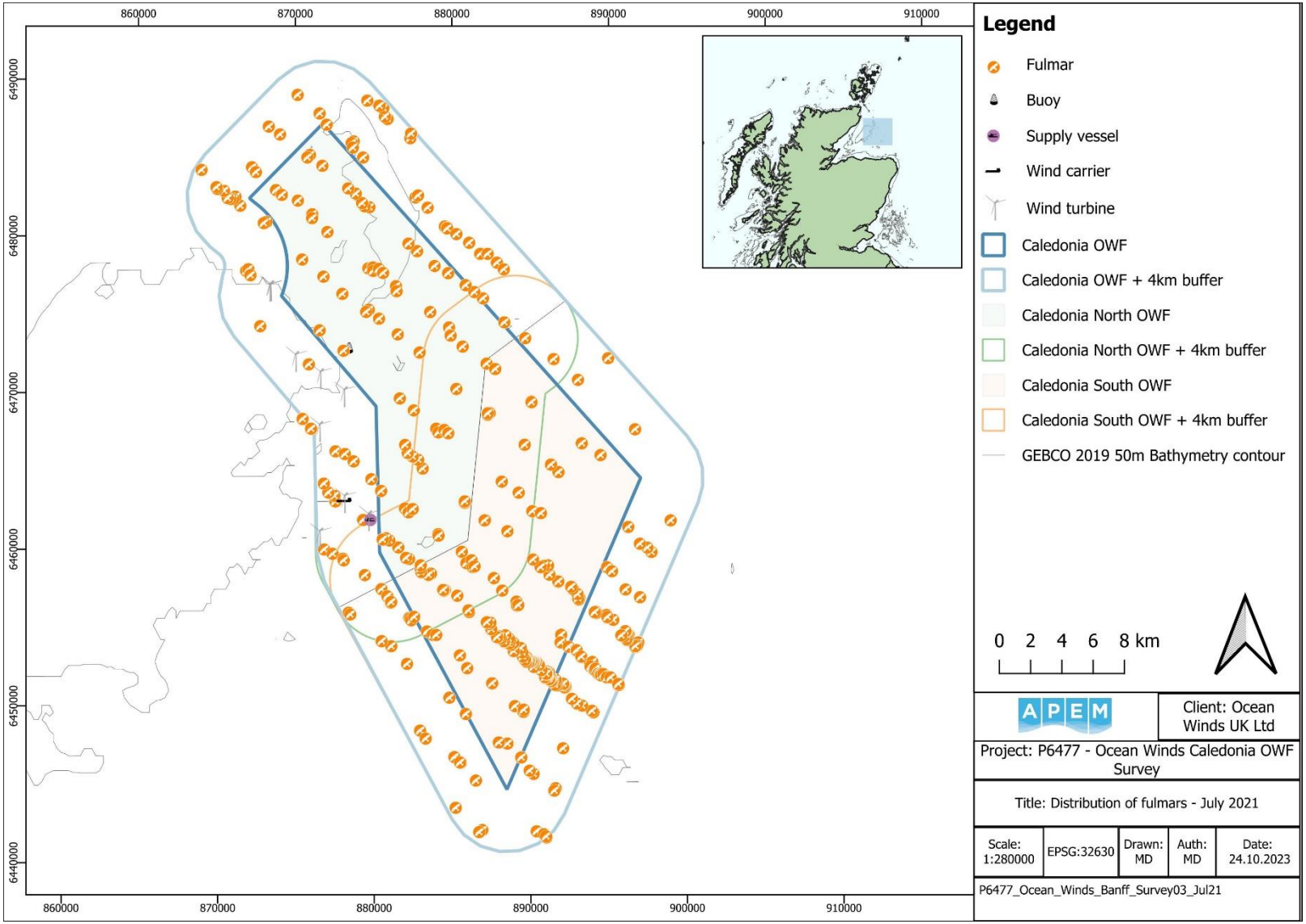



**Figure A4.264 Distribution of fulmars recorded in the Survey Area in July 2021**

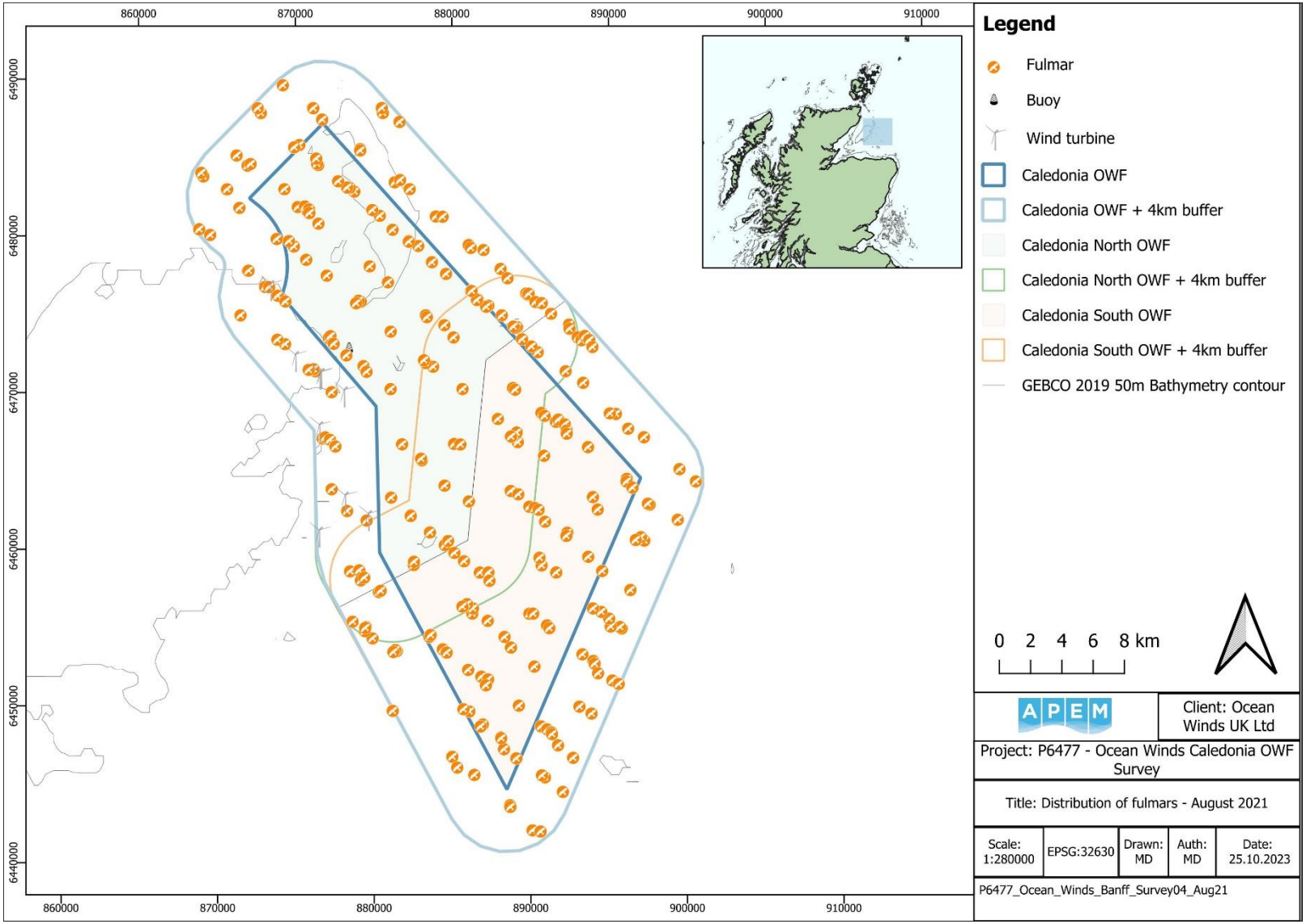



**Figure A4.265 Distribution of fulmars recorded in the Survey Area in August 2021**

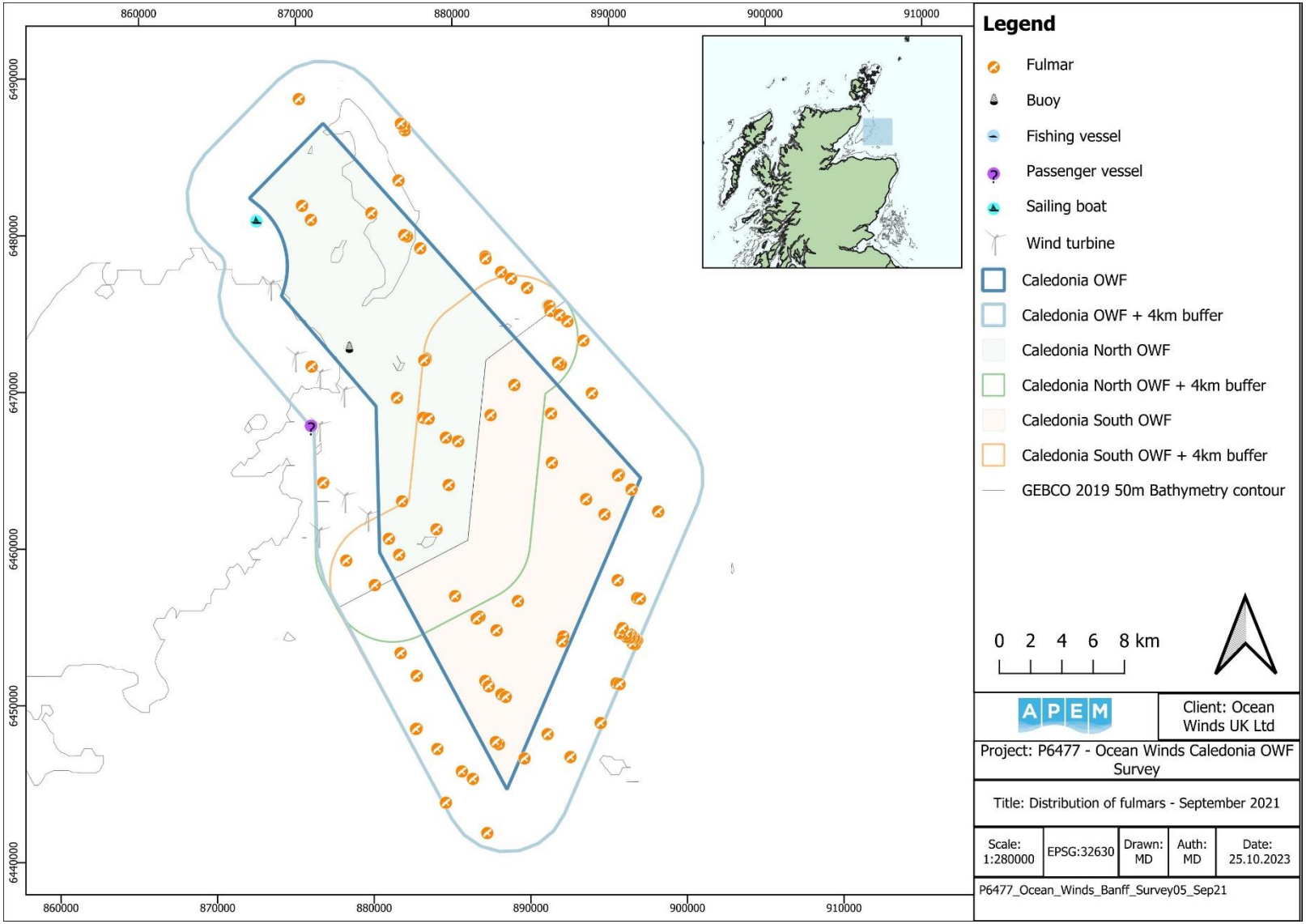



**Figure A4.266 Distribution of fulmars recorded in the Survey Area in September 2021**

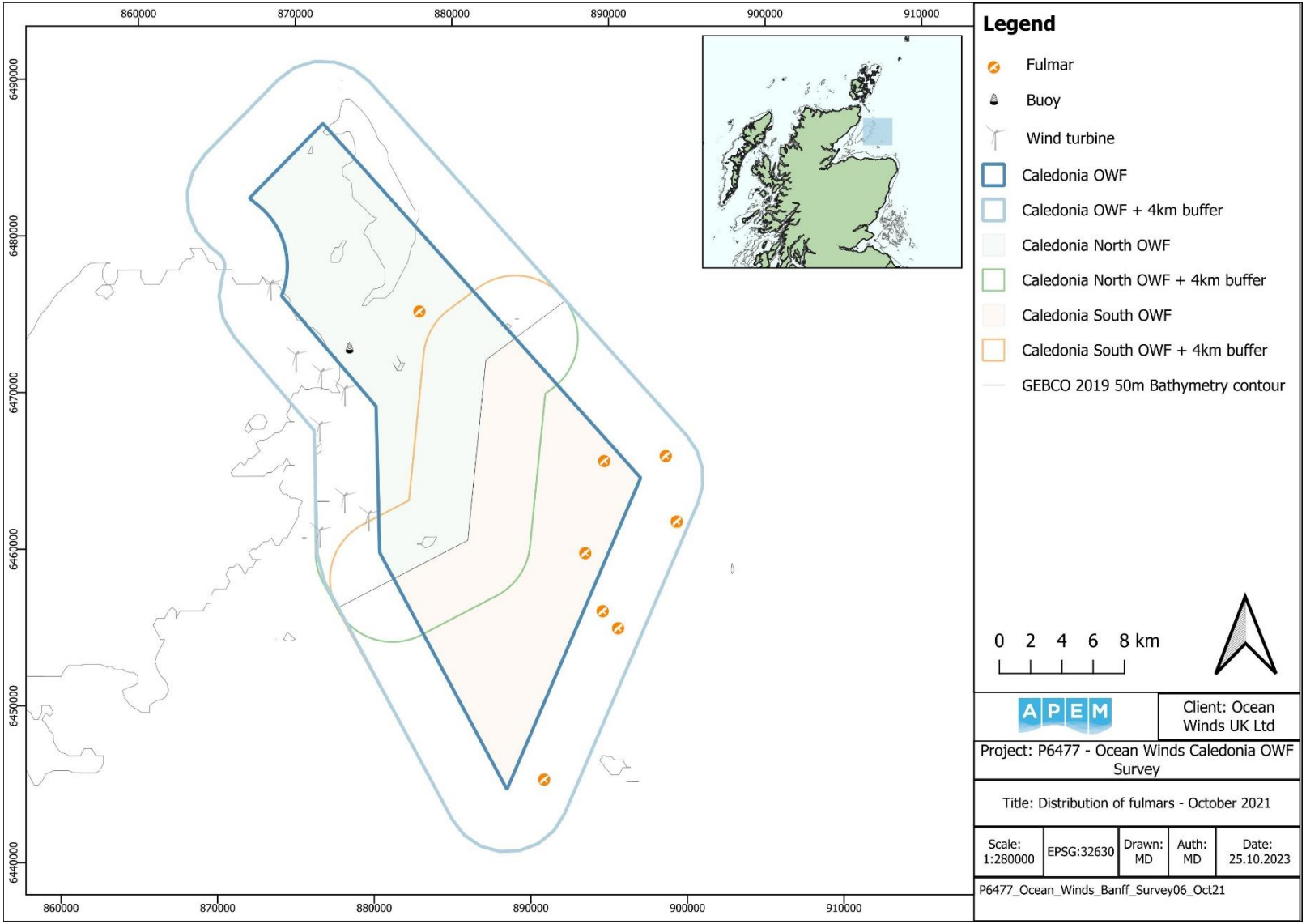



**Figure A4.267 Distribution of fulmars recorded in the Survey Area in October 2021**

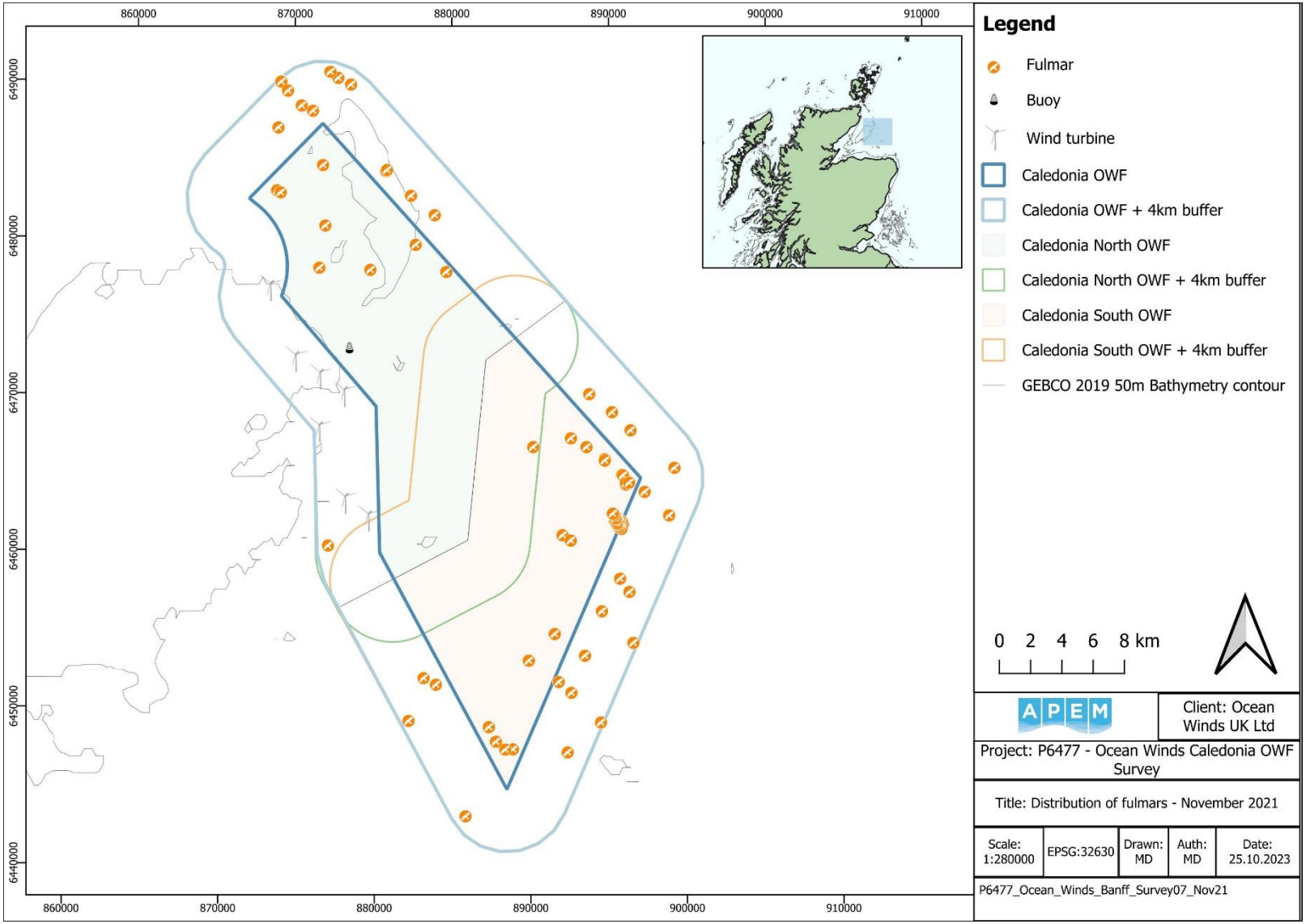



**Figure A4.268 Distribution of fulmars recorded in the Survey Area in November 2021**

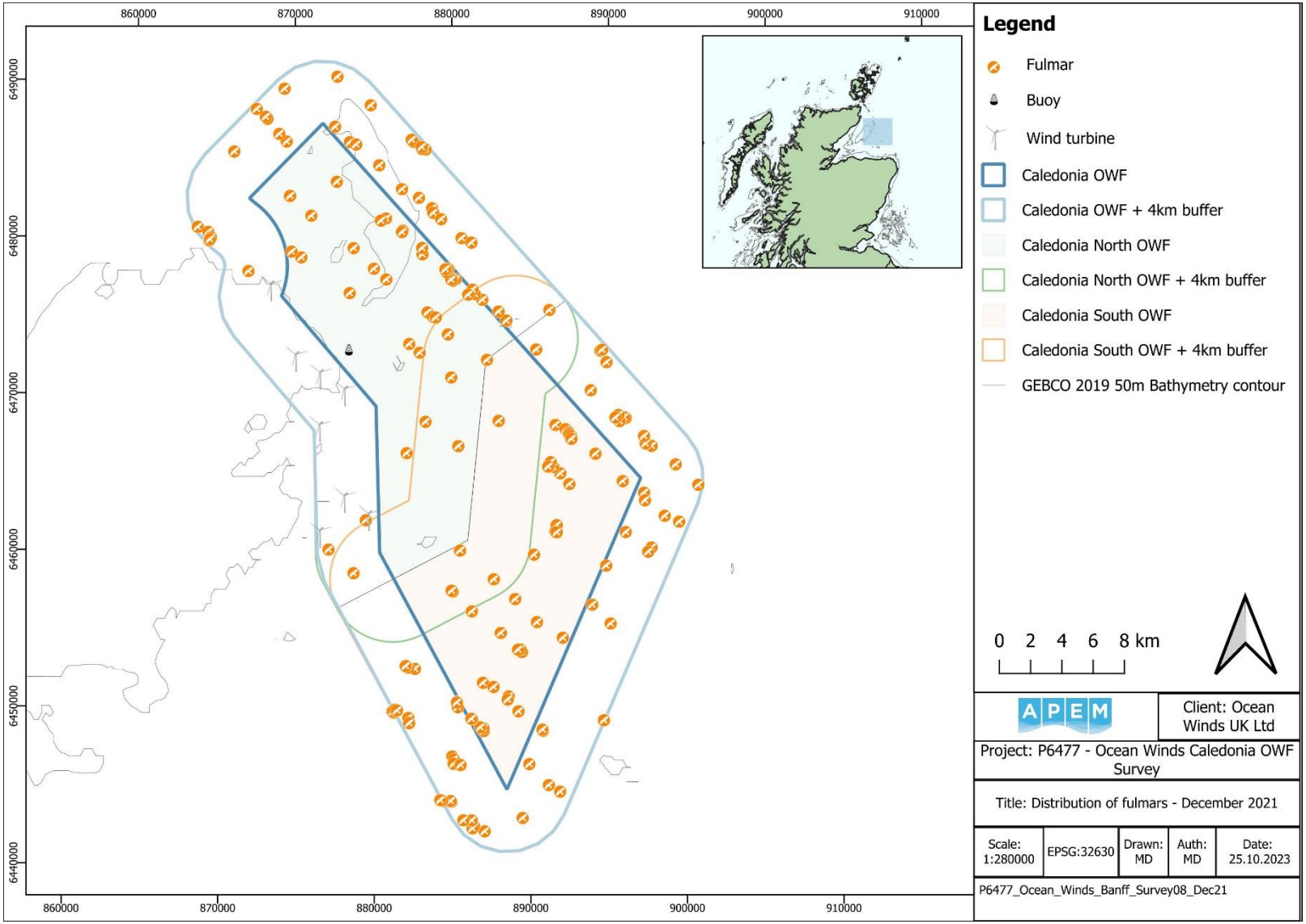



**Figure A4.269 Distribution of fulmars recorded in the Survey Area in December 2021**

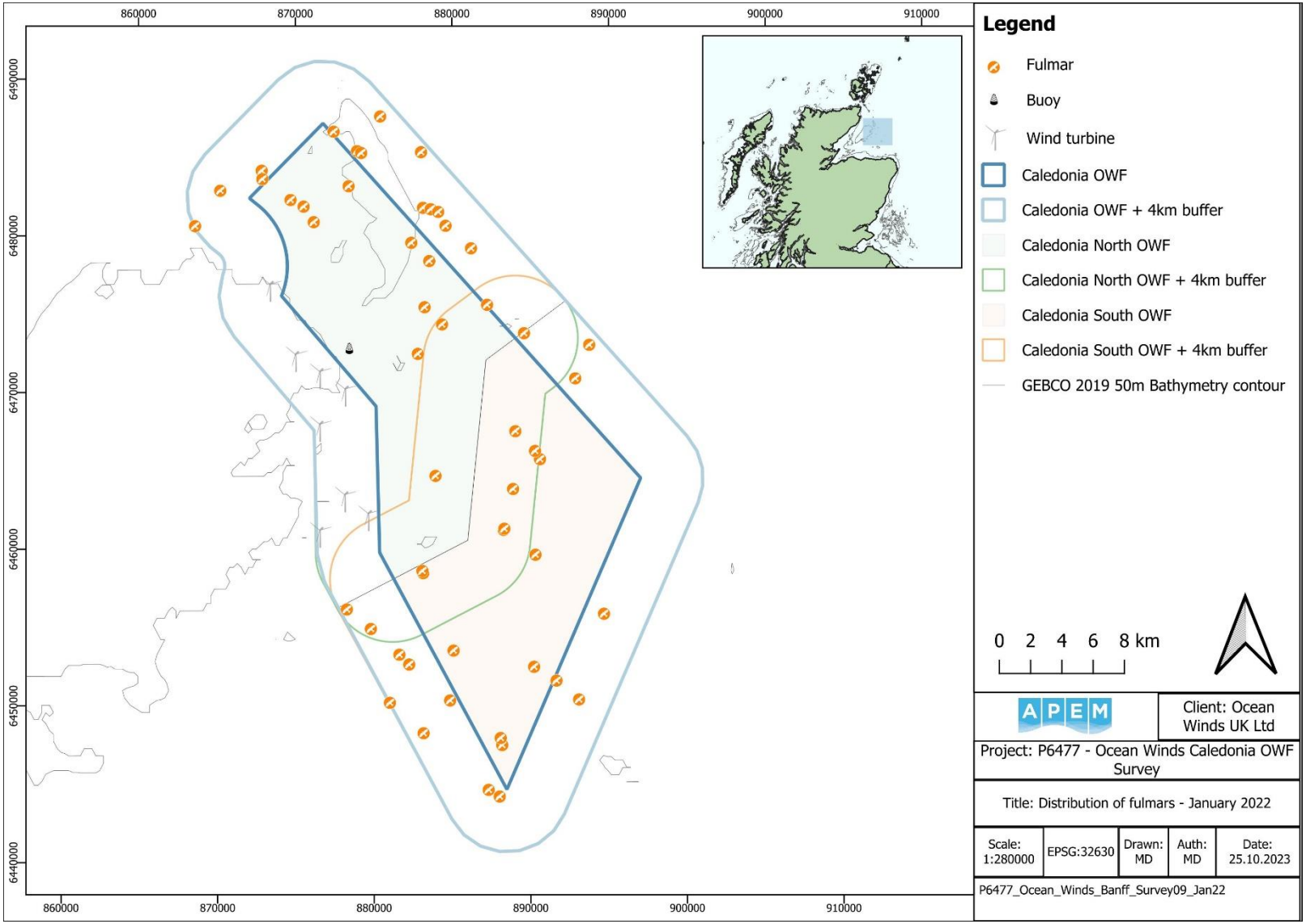



**Figure A4.270 Distribution of fulmars recorded in the Survey Area in January 2022**

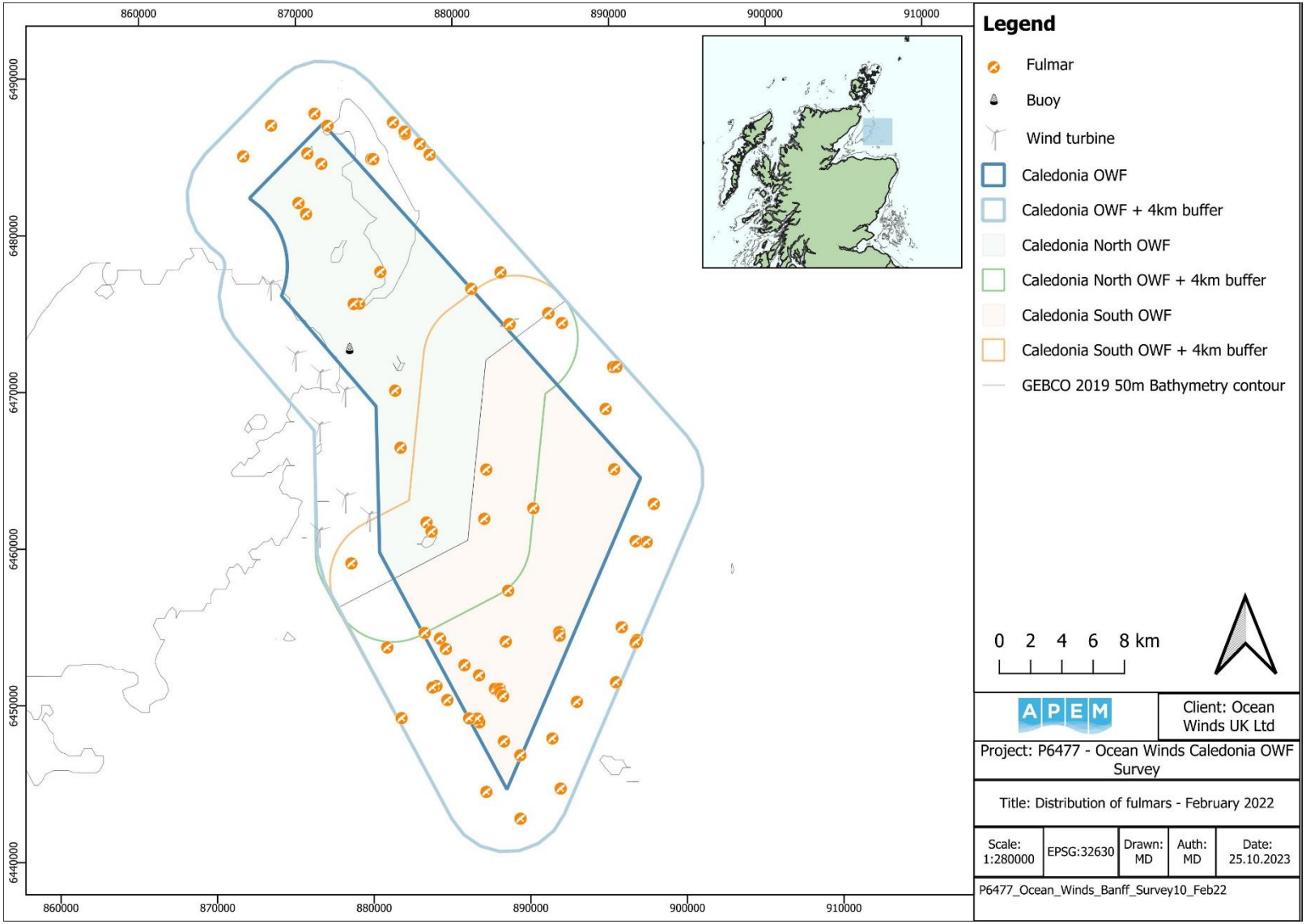



**Figure A4.271 Distribution of fulmars recorded in the Survey Area in February 2022**

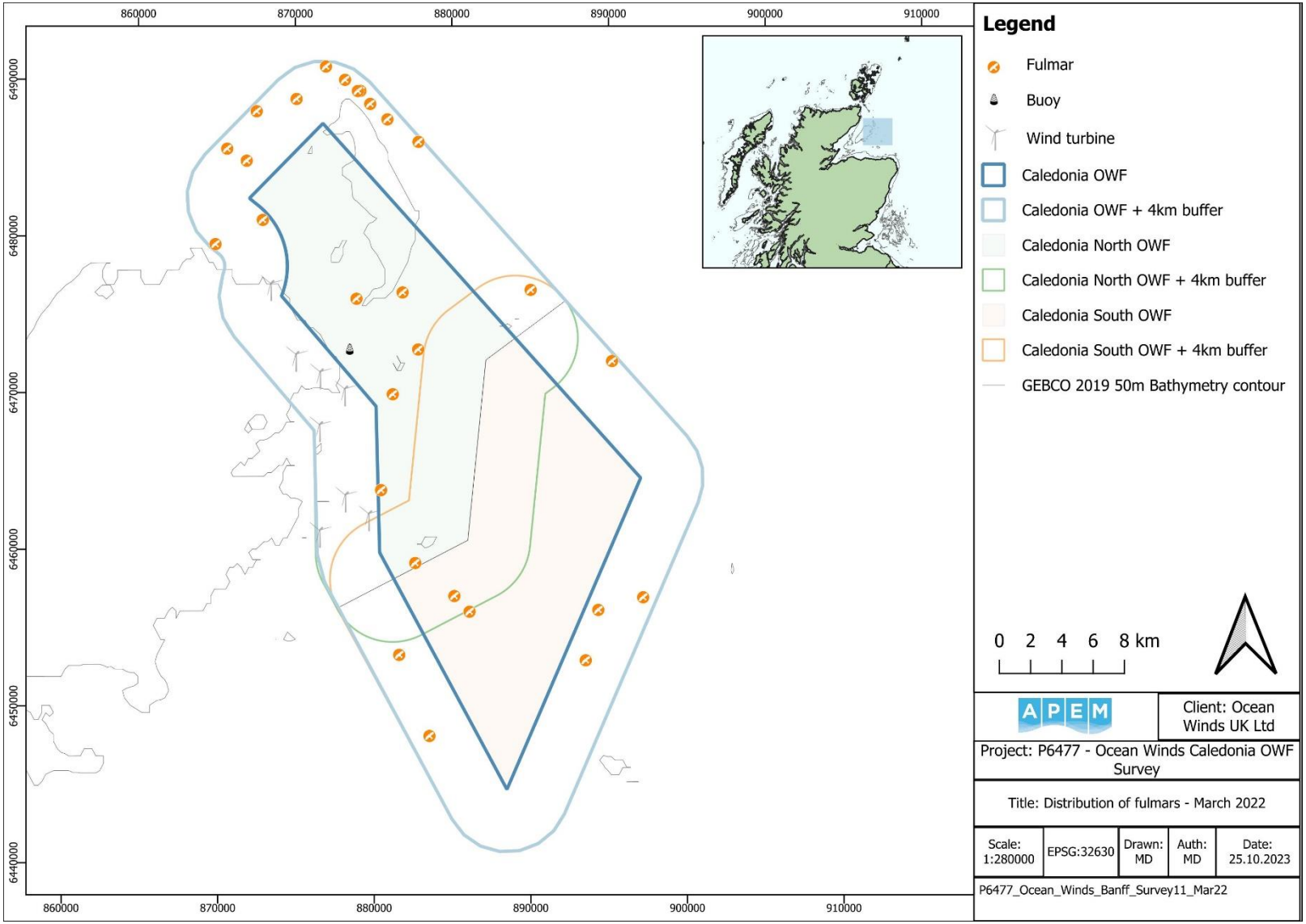



**Figure A4.272 Distribution of fulmars recorded in the Survey Area in March 2022**

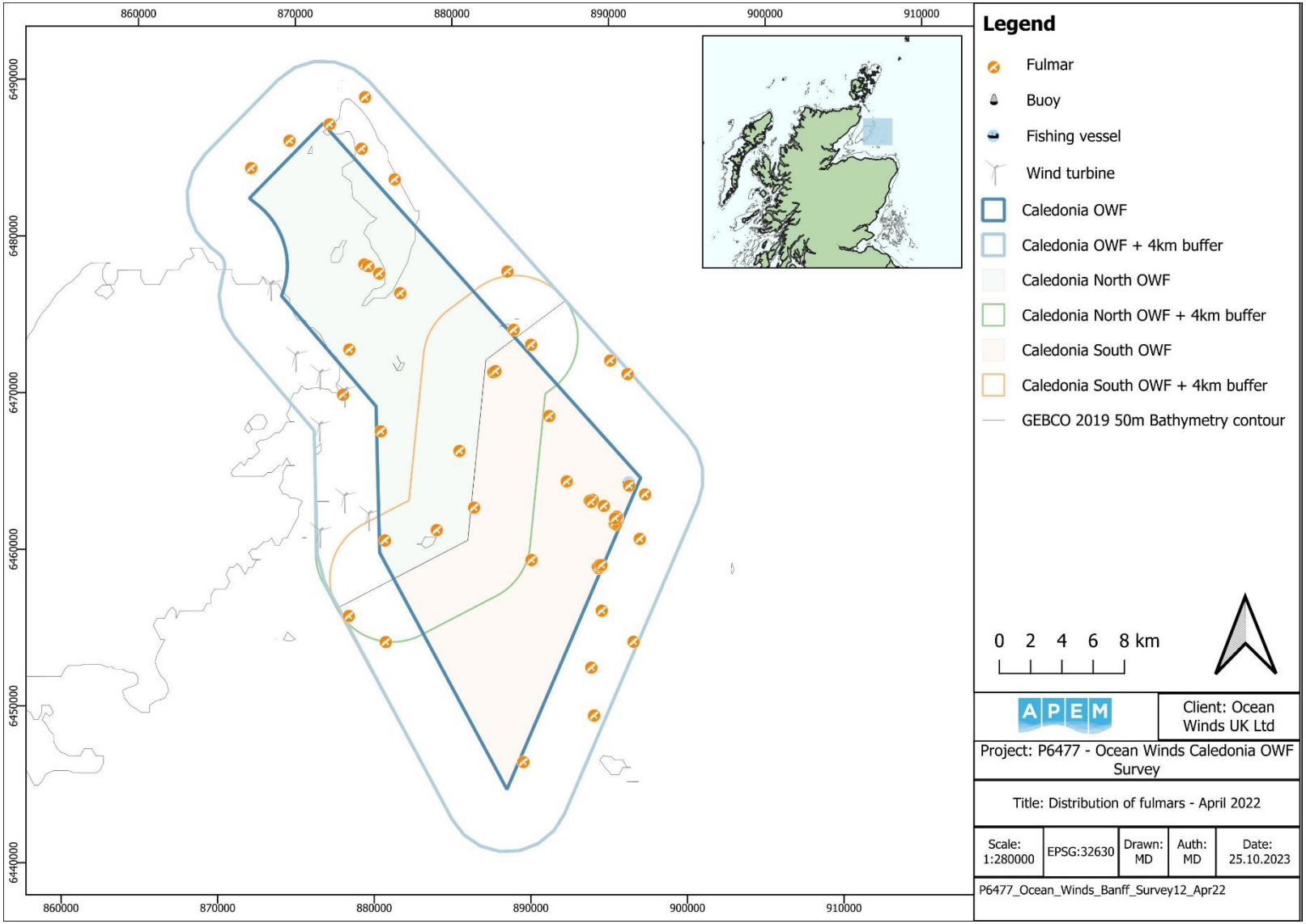



**Figure A4.273 Distribution of fulmars recorded in the Survey Area in April 2022**

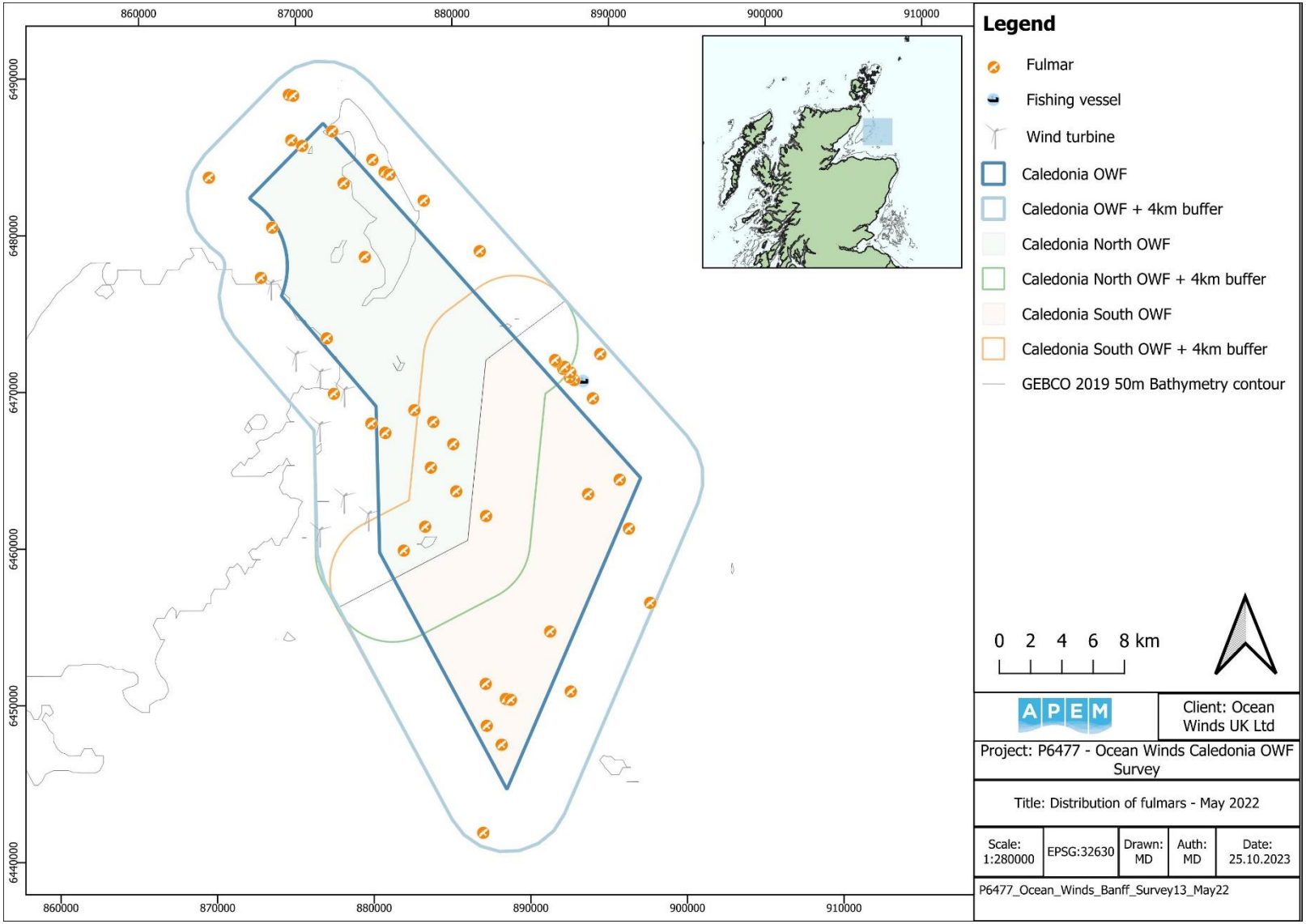



**Figure A4.274 Distribution of fulmars recorded in the Survey Area in May 2022**

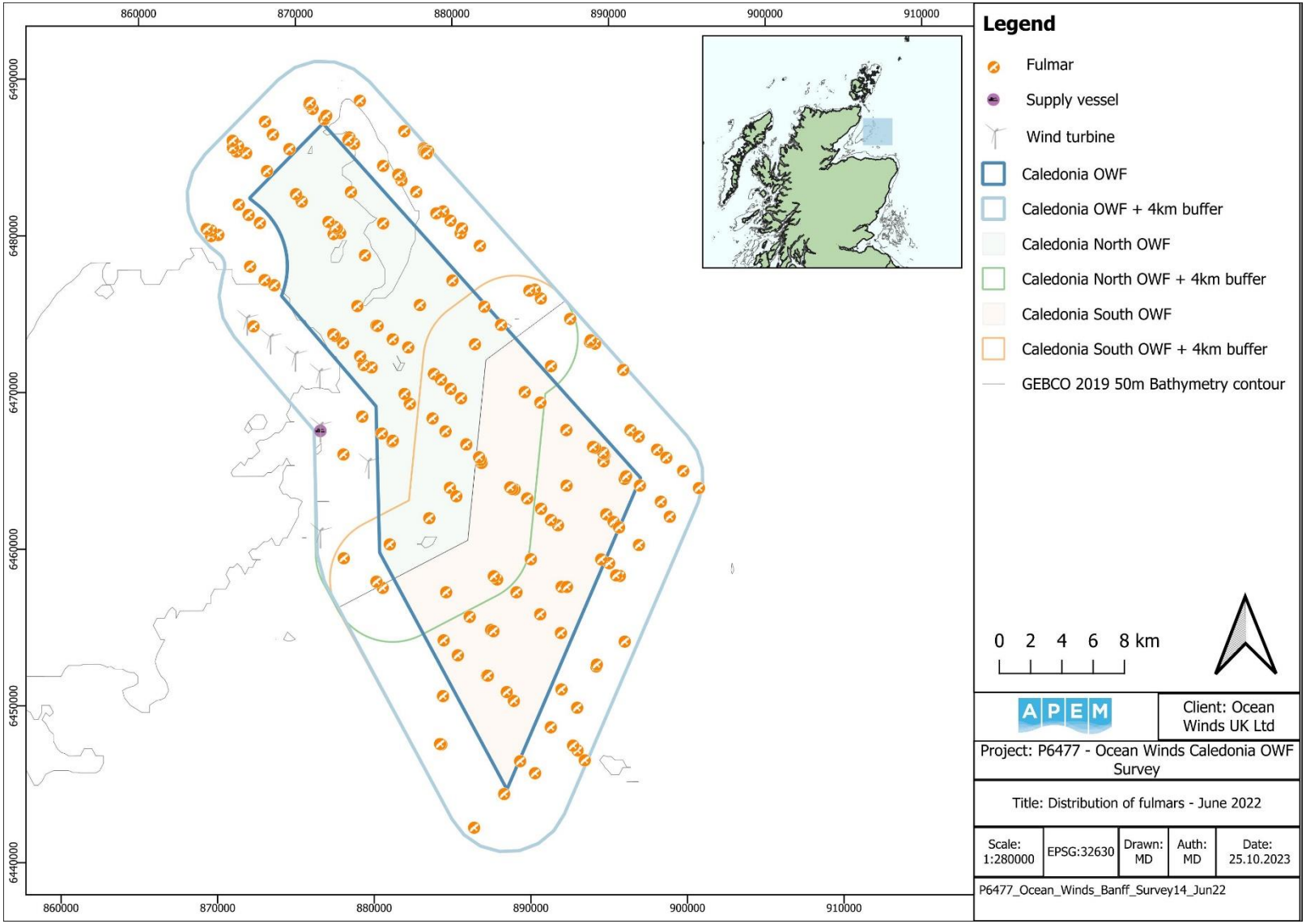



**Figure A4.275 Distribution of fulmars recorded in the Survey Area in June 2022**

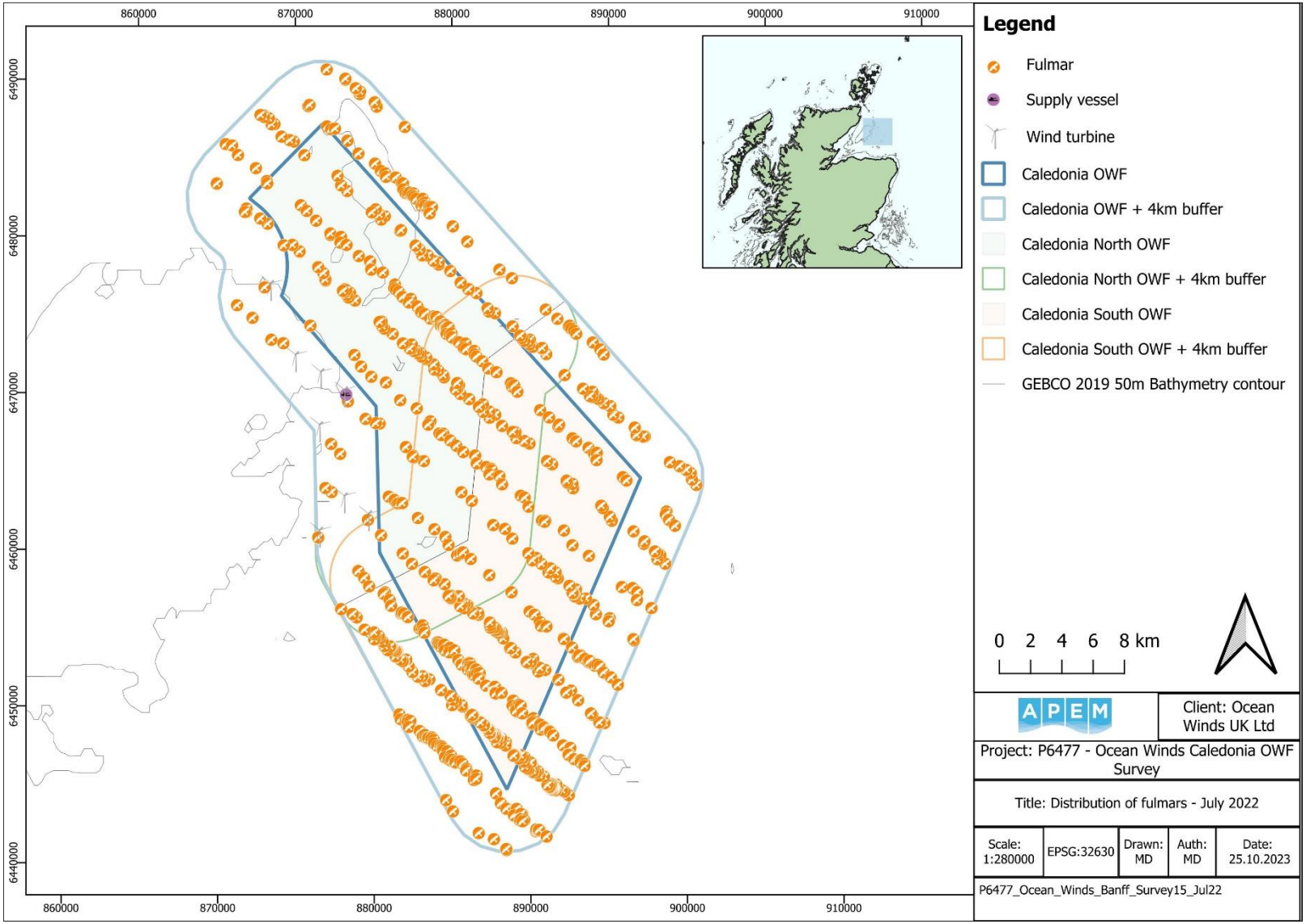



**Figure A4.276 Distribution of fulmars recorded in the Survey Area in July 2022**

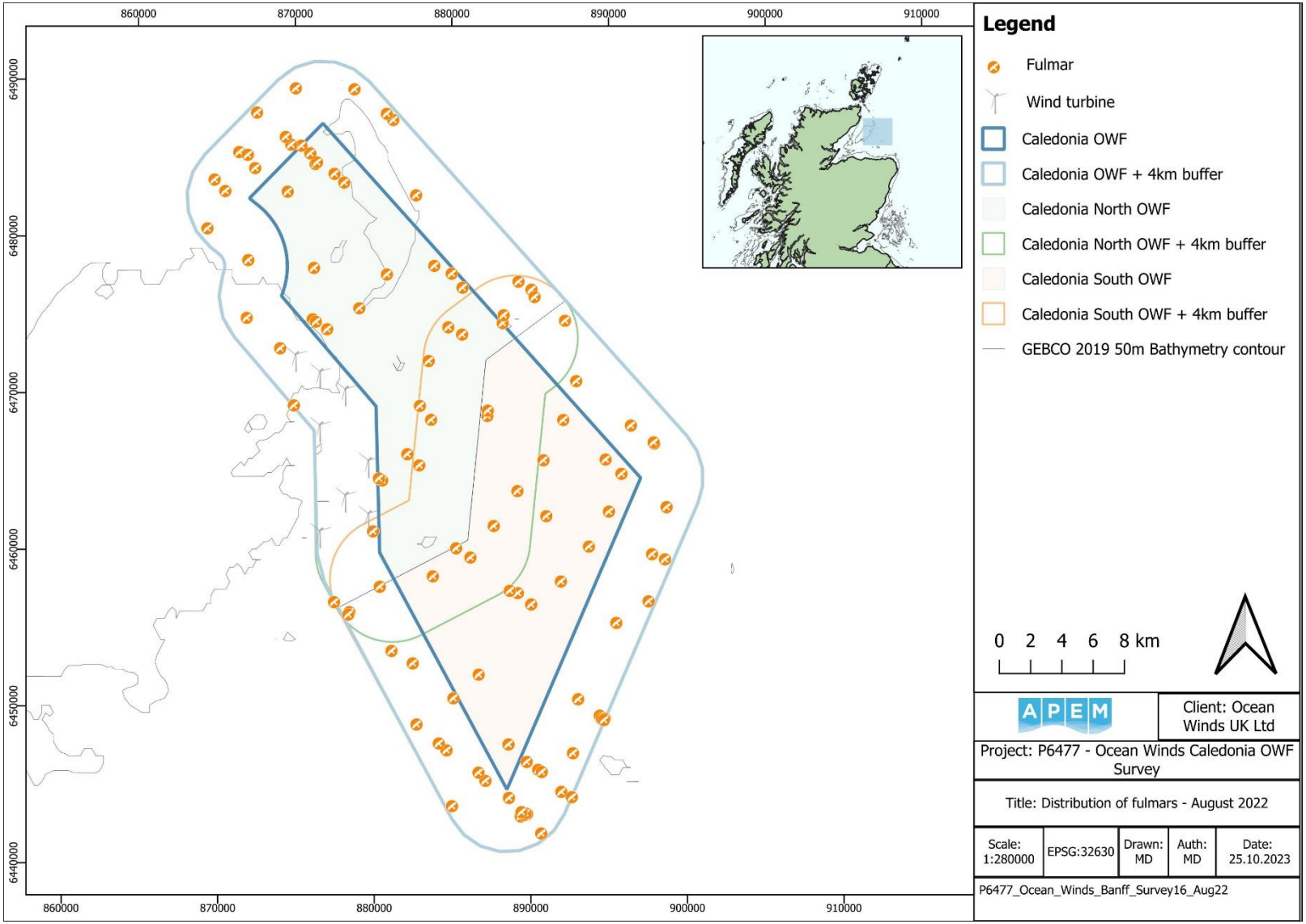



**Figure A4.277 Distribution of fulmars recorded in the Survey Area in August 2022**

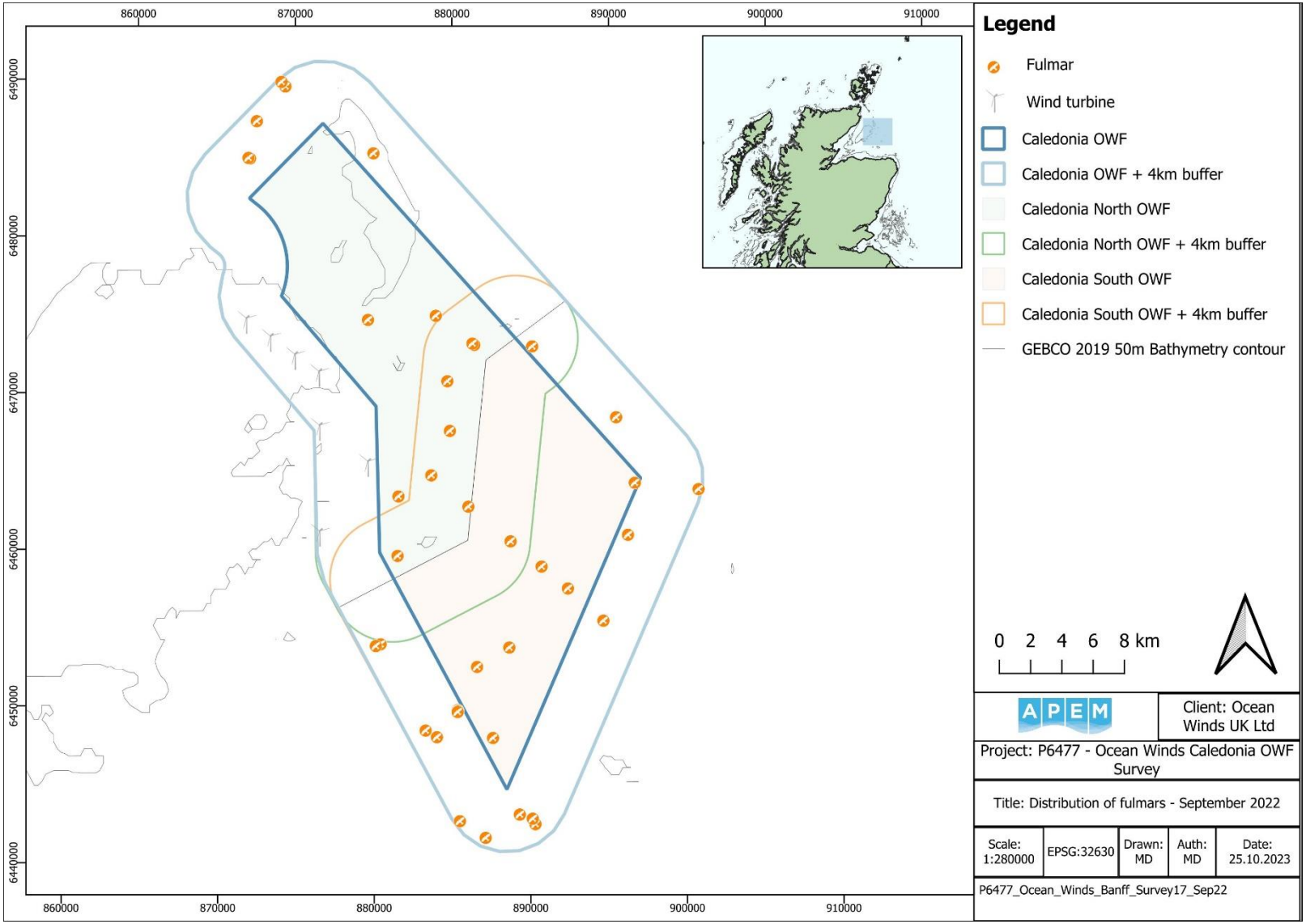



**Figure A4.278 Distribution of fulmars recorded in the Survey Area in September 2022**

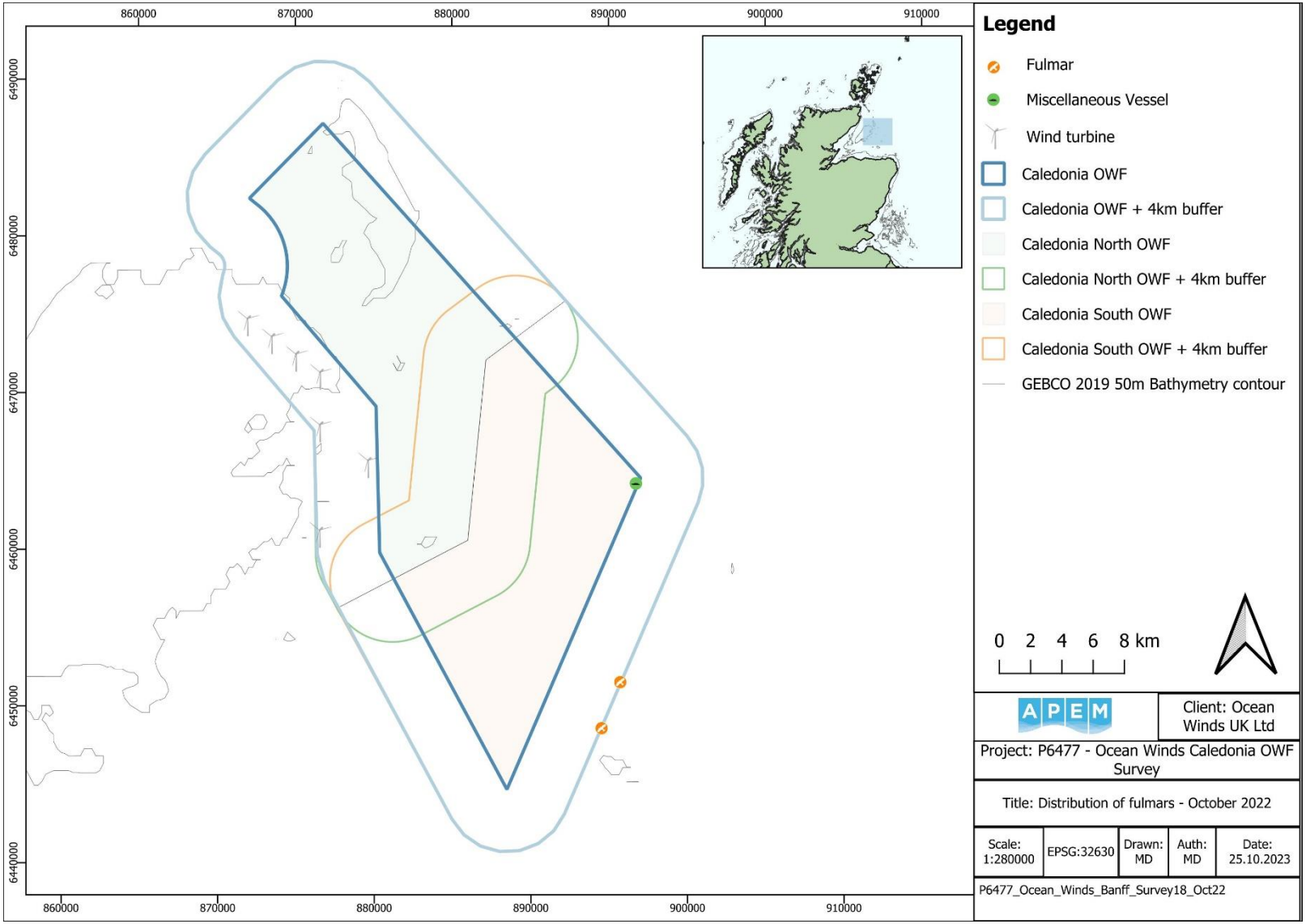



**Figure A4.279 Distribution of fulmars recorded in the Survey Area in October 2022**

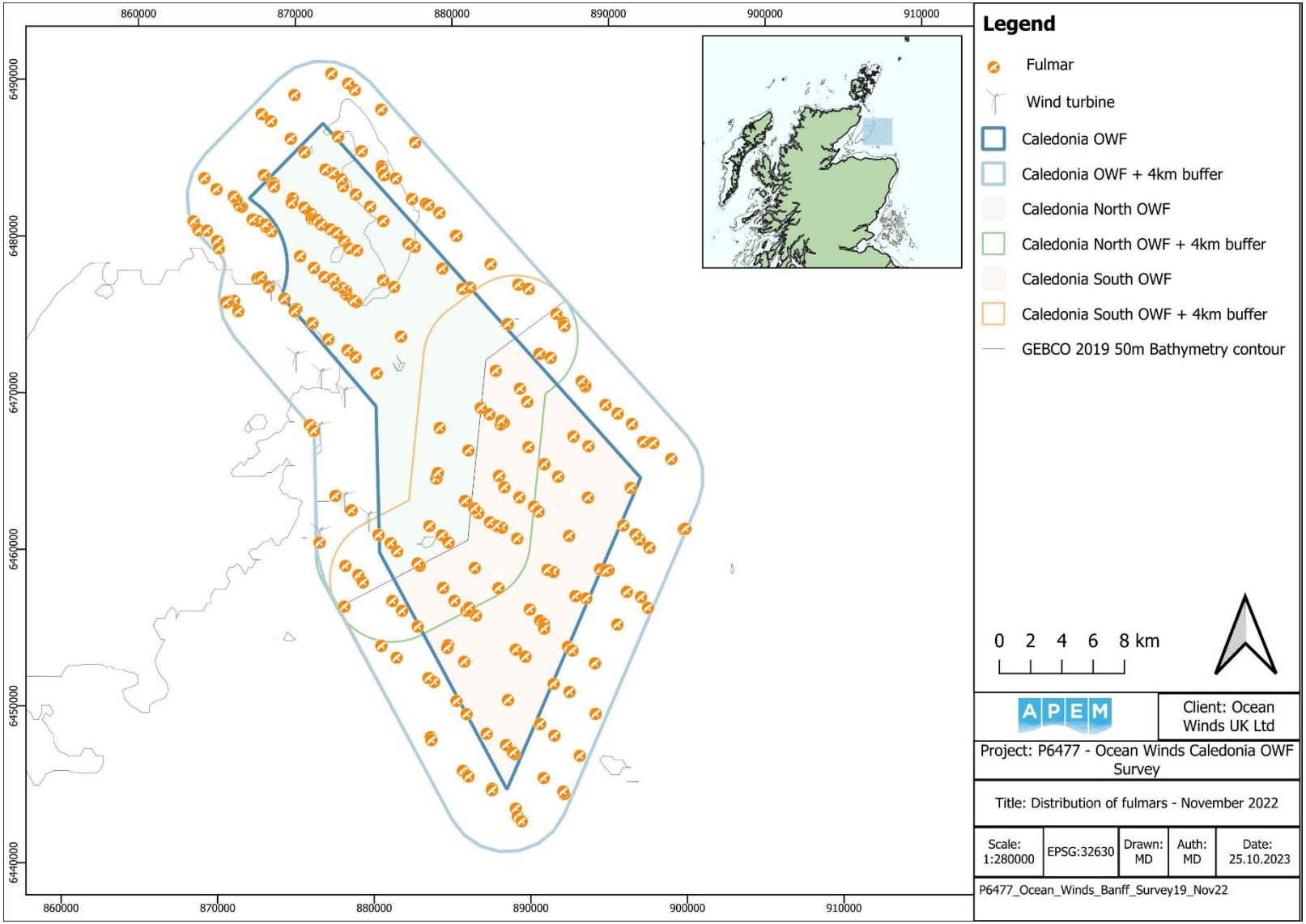



**Figure A4.280 Distribution of fulmars recorded in the Survey Area in November 2022**

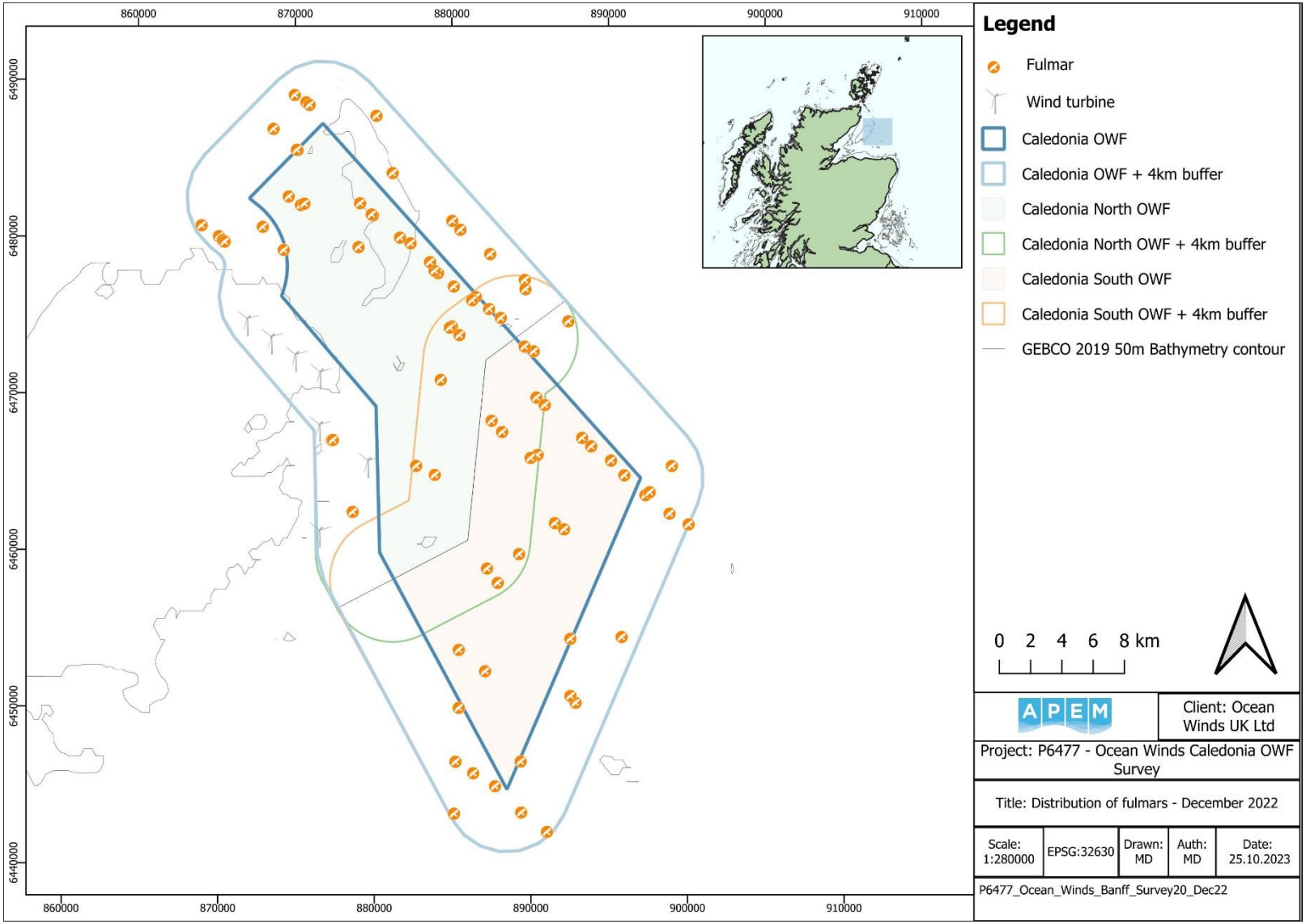



**Figure A4.281 Distribution of fulmars recorded in the Survey Area in December 2022**

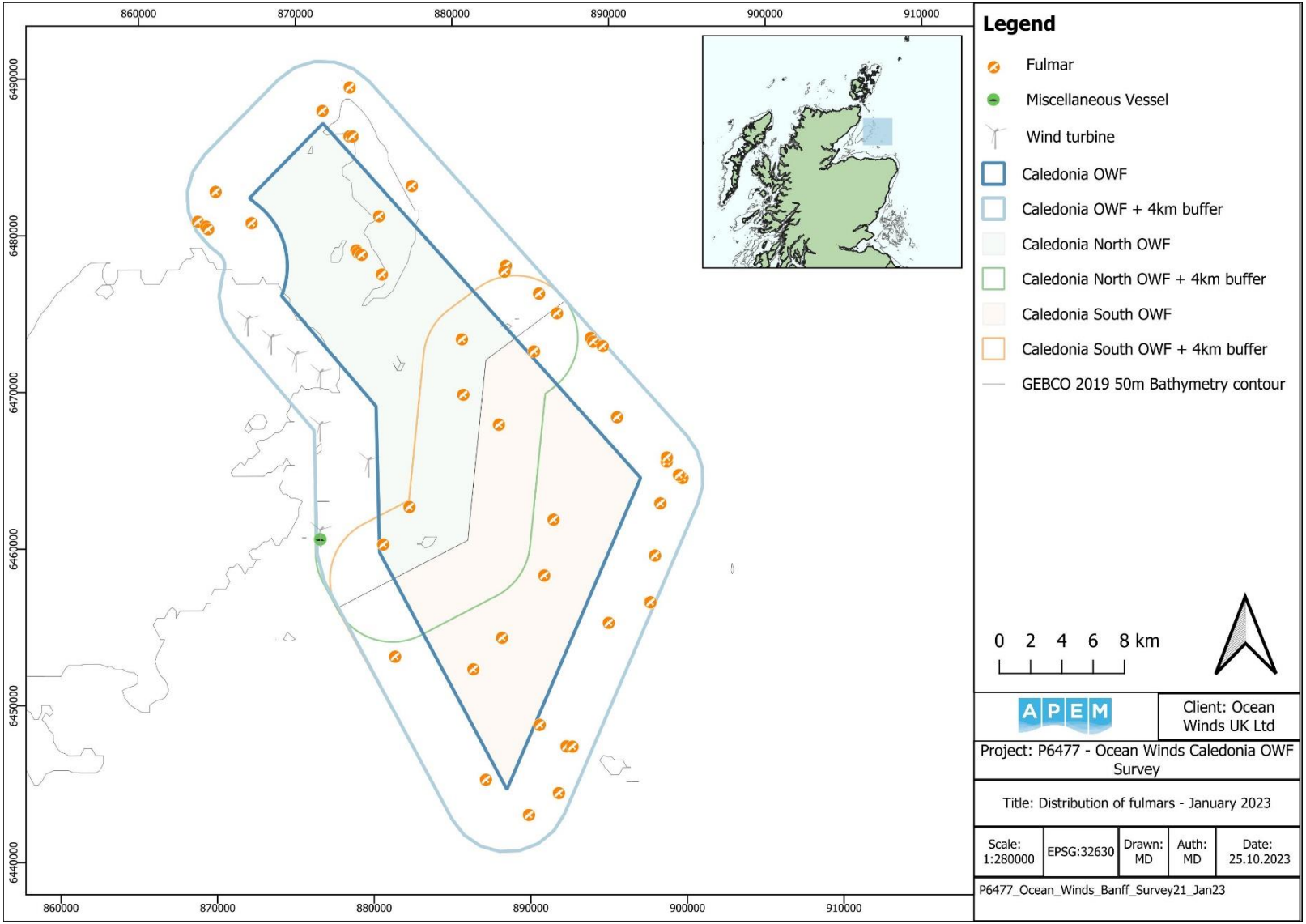



**Figure A4.282 Distribution of fulmars recorded in the Survey Area in January 2023**

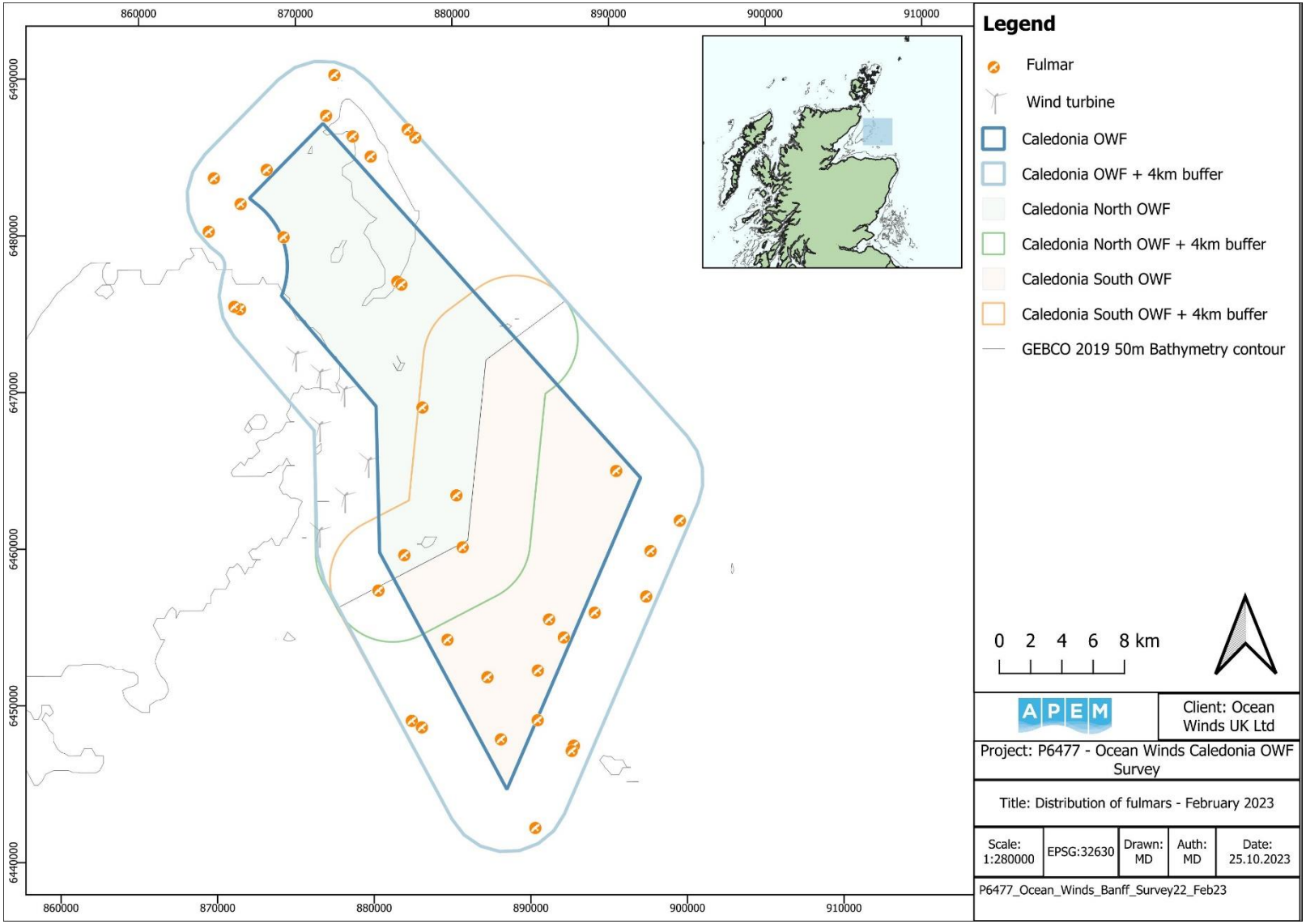



**Figure A4.283 Distribution of fulmars recorded in the Survey Area in February 2023**

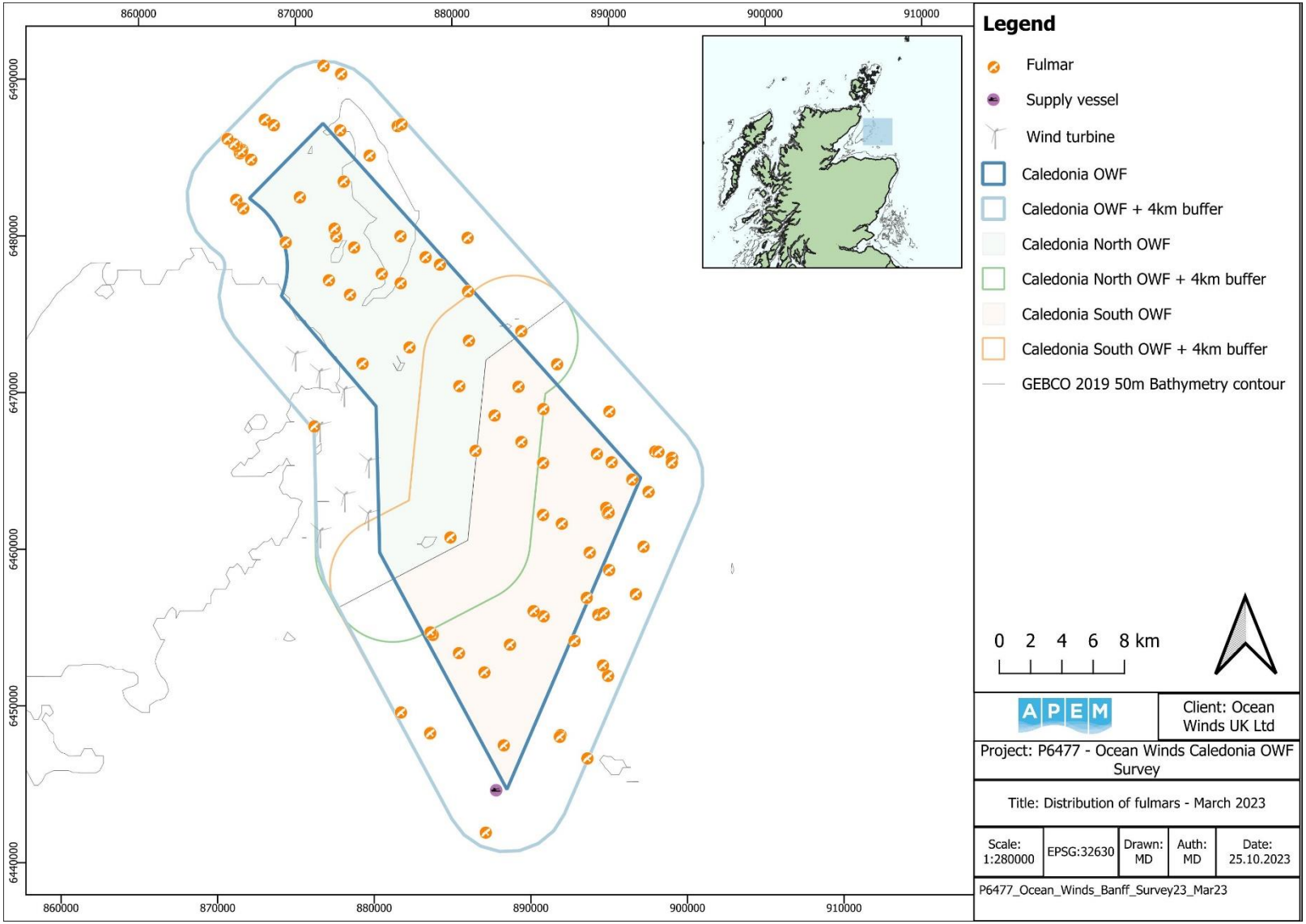



**Figure A4.284 Distribution of fulmars recorded in the Survey Area in March 2023**

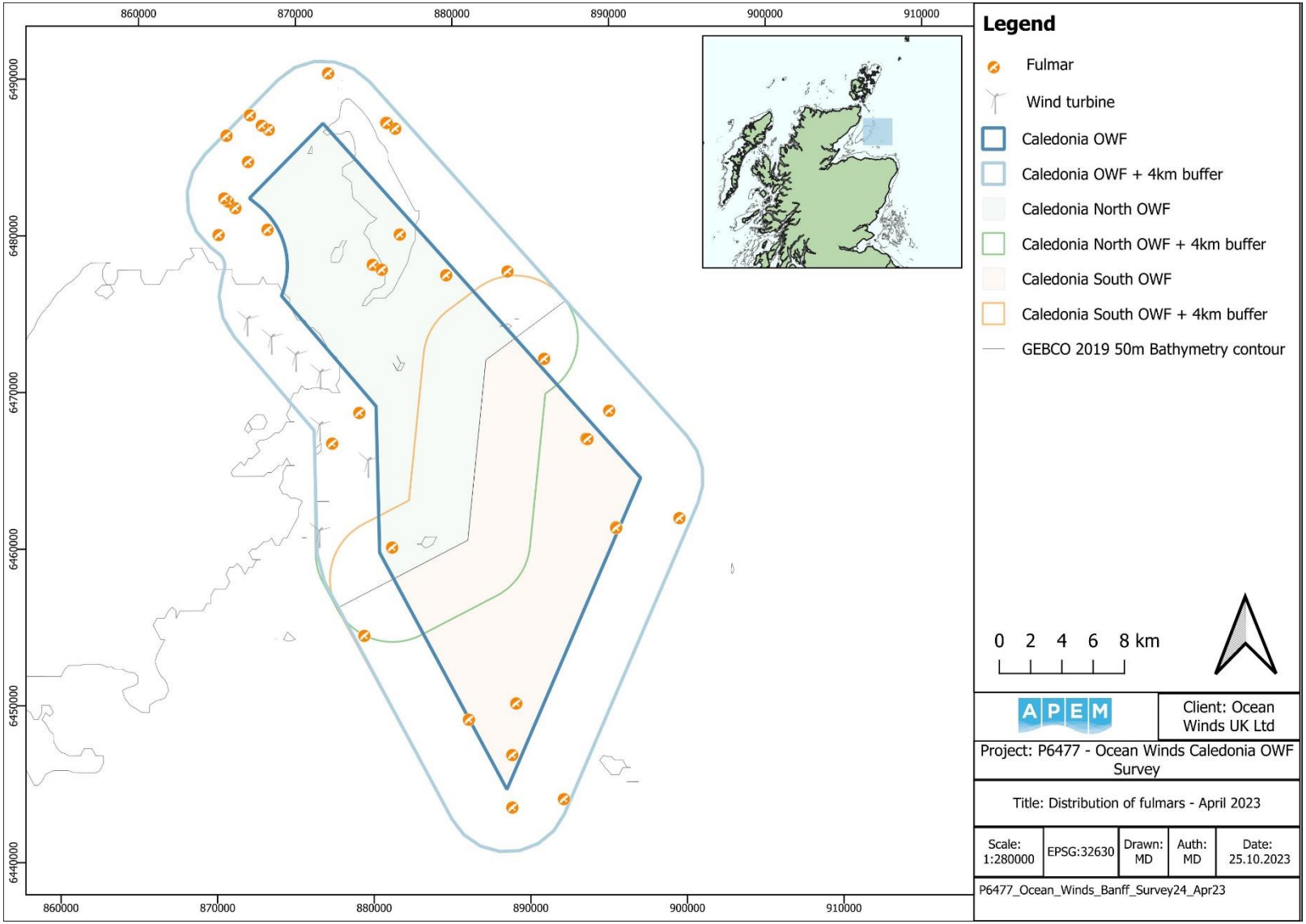



**Figure A4.285 Distribution of fulmars recorded in the Survey Area in April 2023**

## Unidentified fulmar and / or gull species

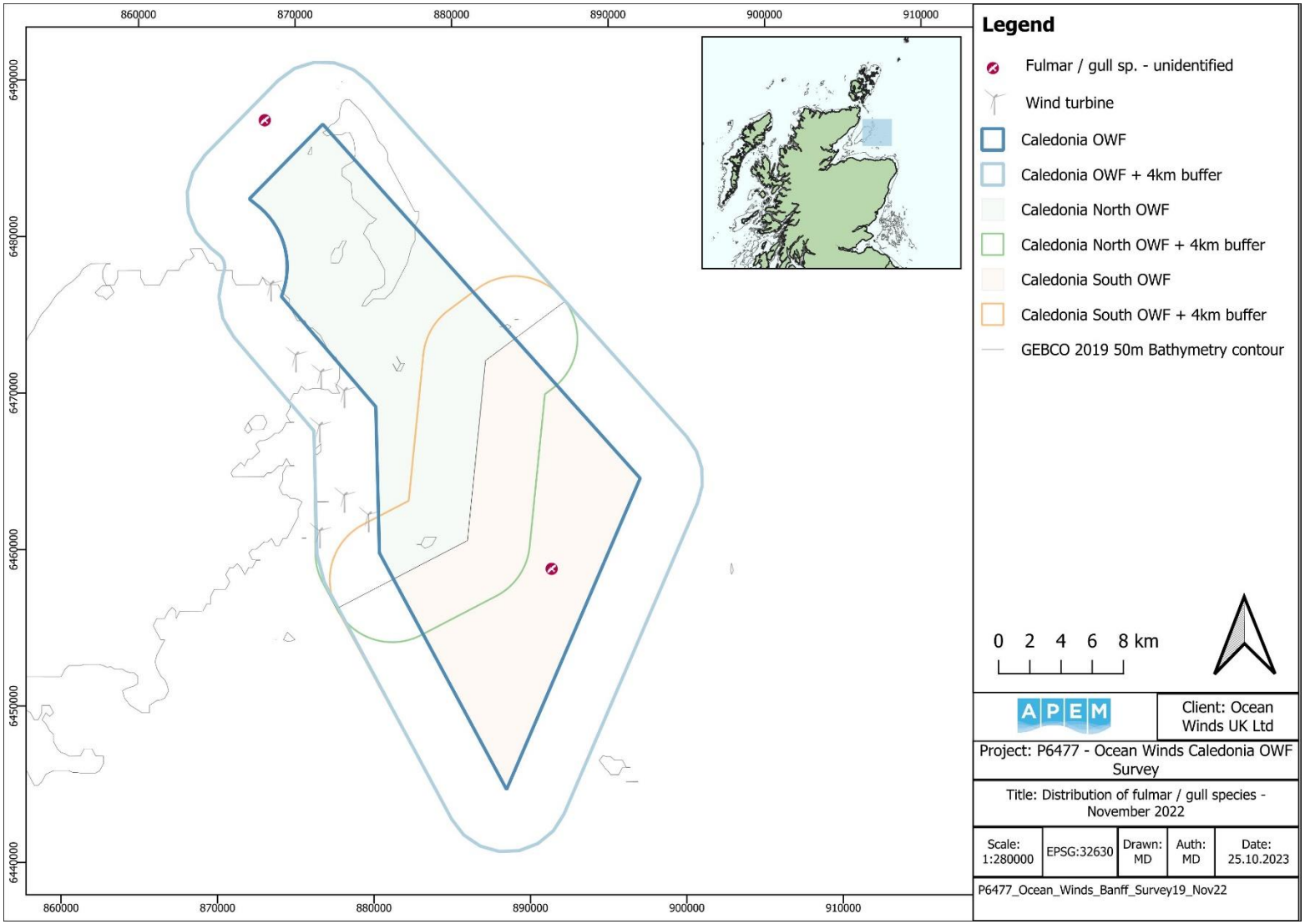



**Figure A4.286 Distribution of fulmar / gull species recorded in the Survey Area in November 2022**

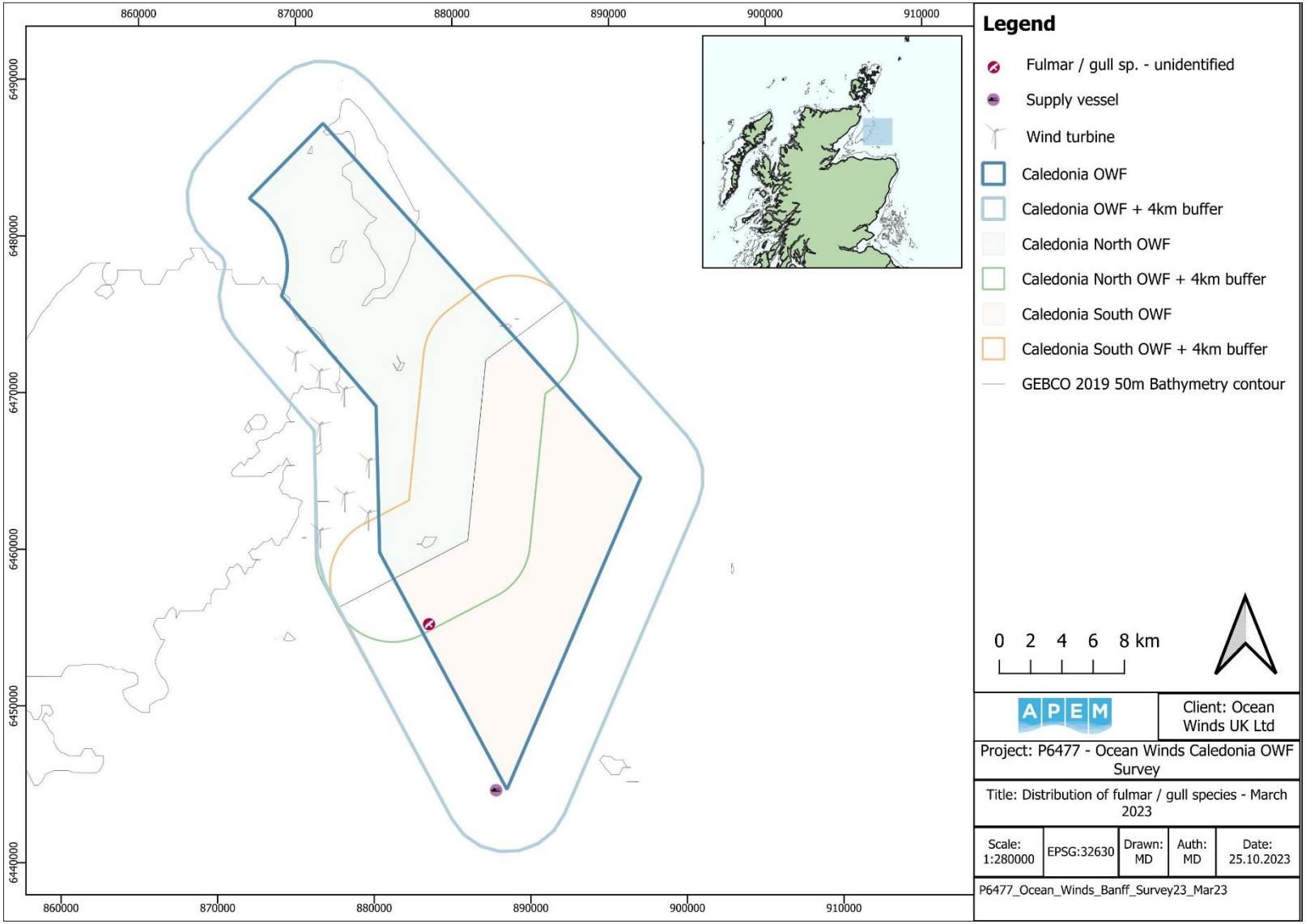



**Figure A4.287 Distribution of fulmar / gull species recorded in the Survey Area in March 2023**

## Sooty shearwater

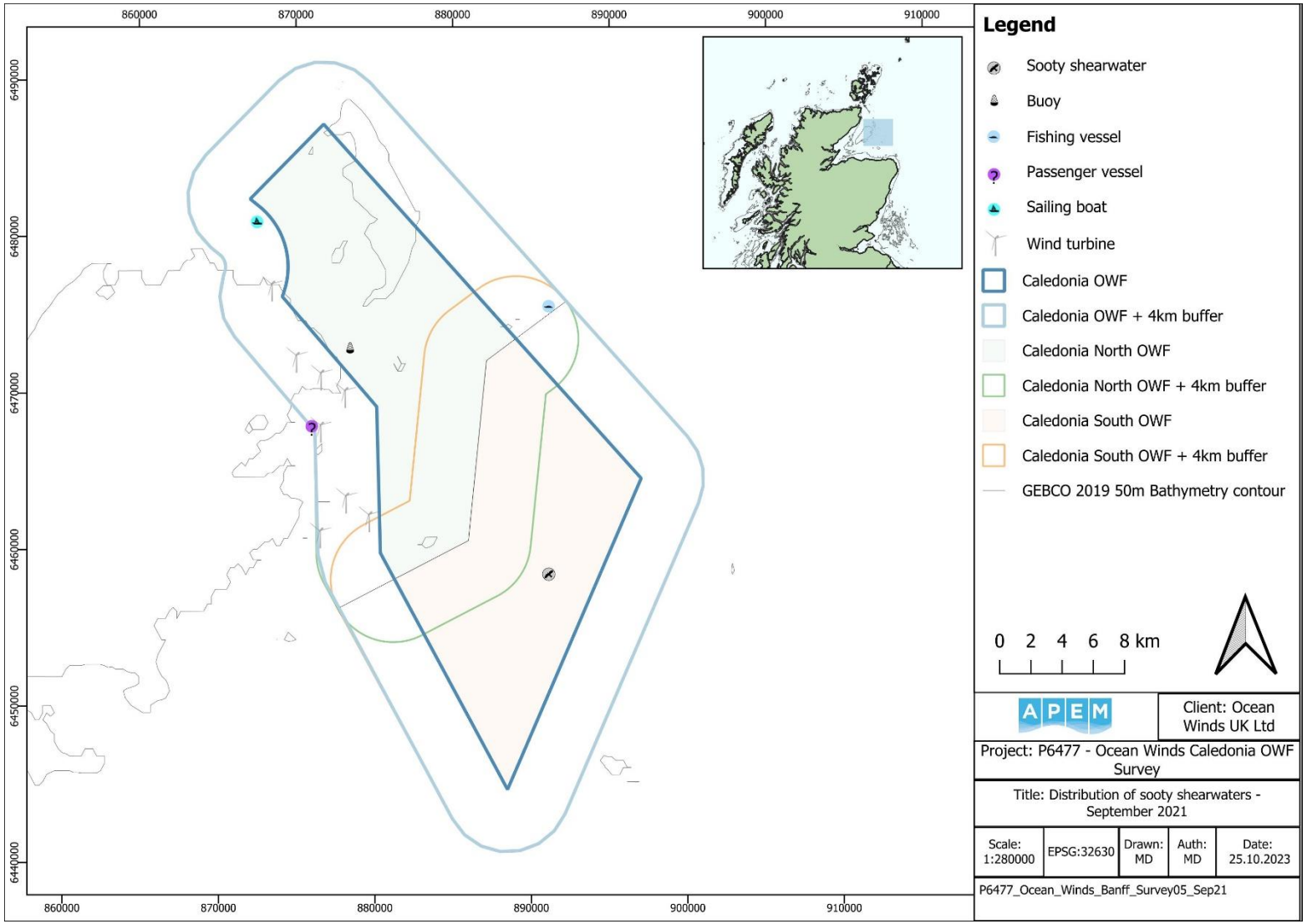



**Figure A4.288 Distribution of sooty shearwaters recorded in the Survey Area in September 2021**

## Manx shearwater

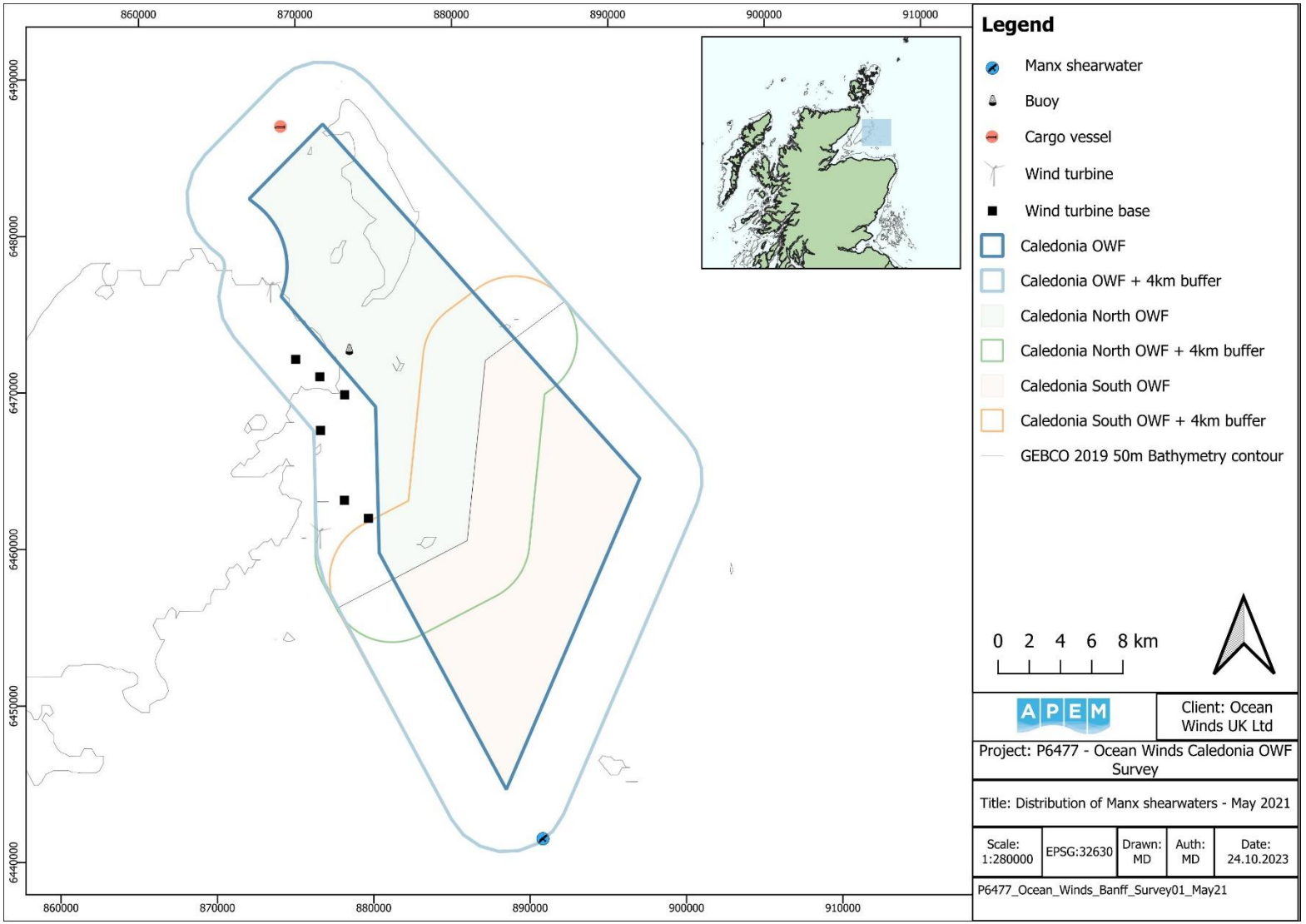



**Figure A4.289 Distribution of Manx shearwaters recorded in the Survey Area in May 2021**

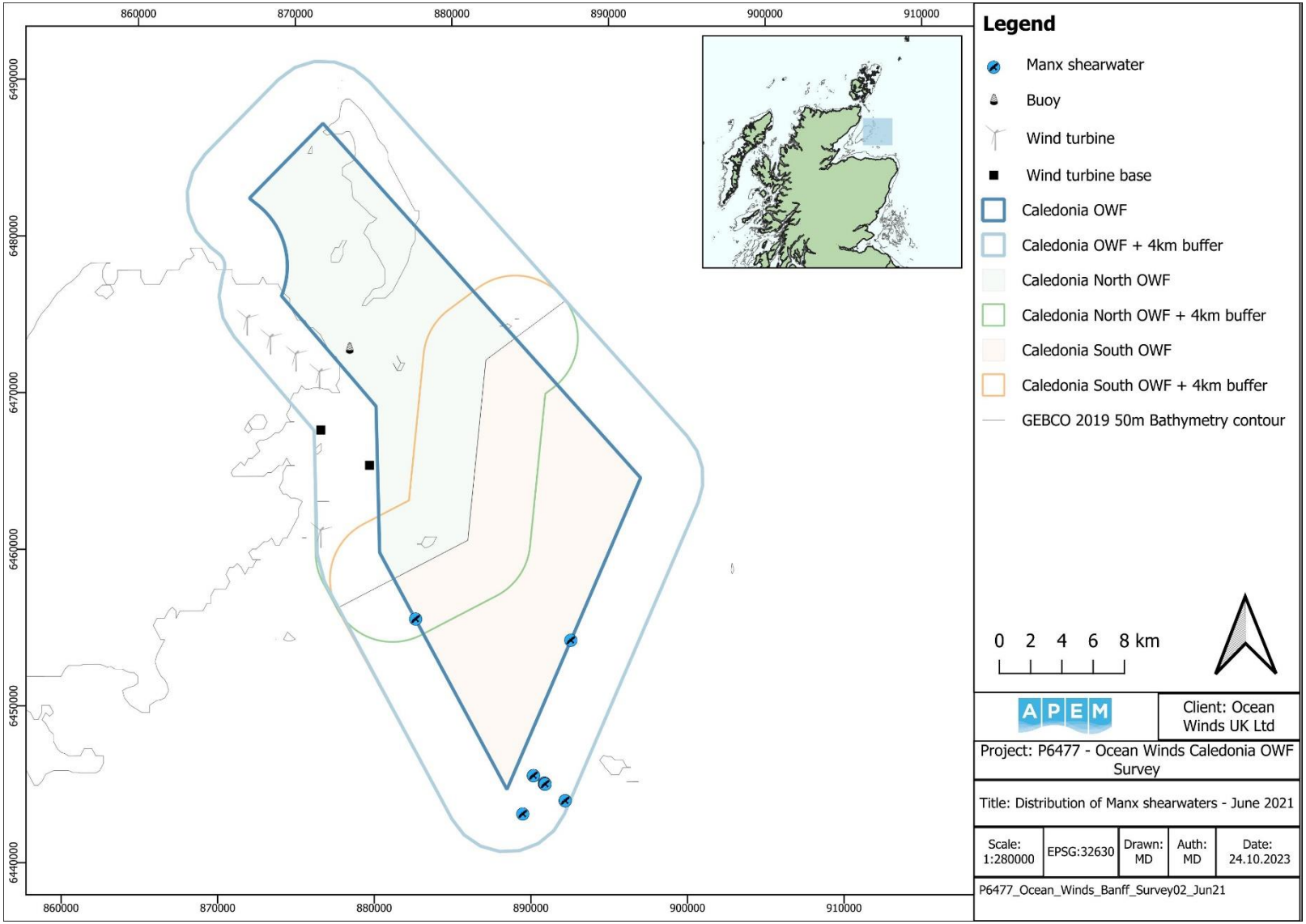



**Figure A4.290 Distribution of Manx shearwaters recorded in the Survey Area in June 2021**

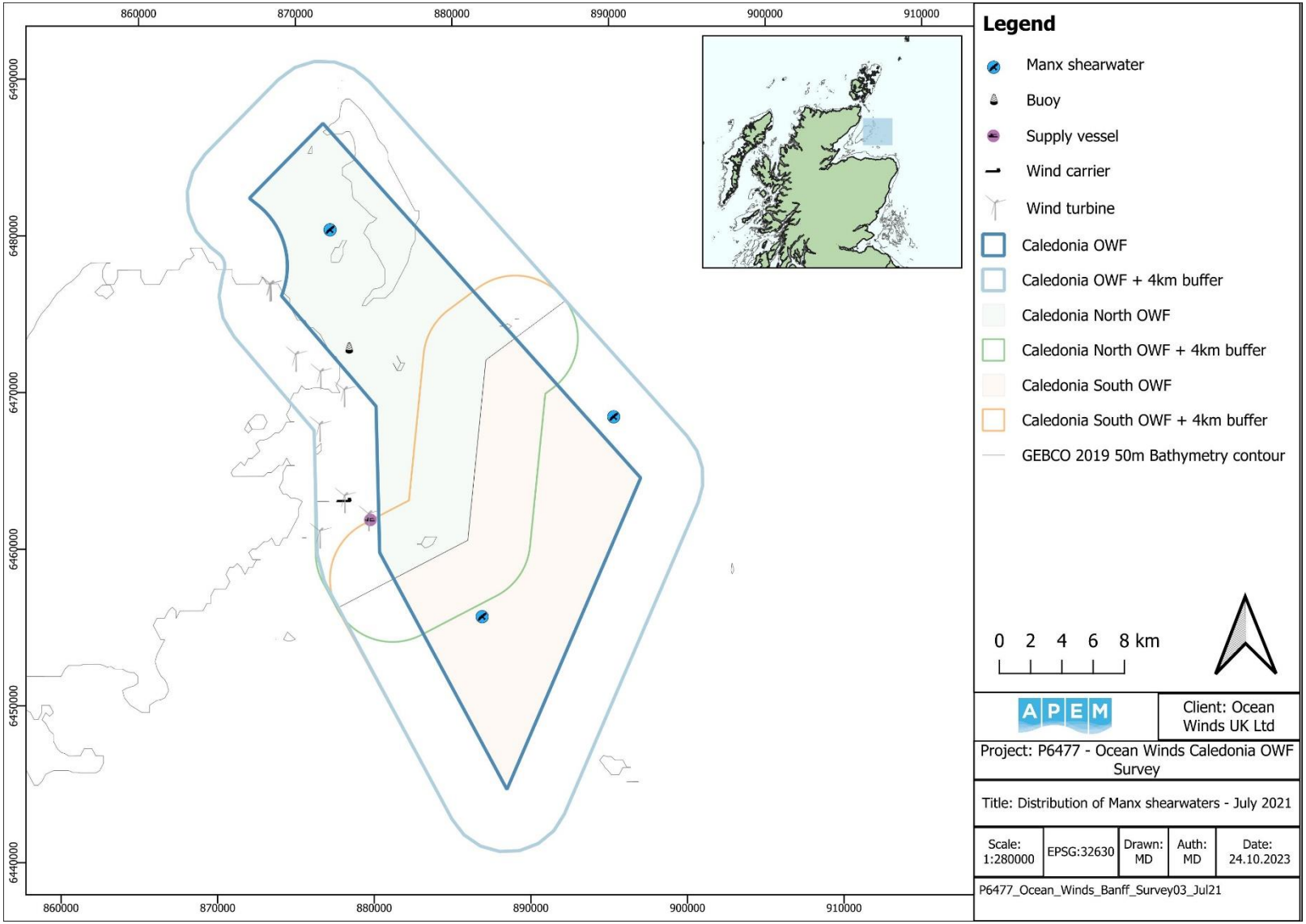



**Figure A4.291 Distribution of Manx shearwaters recorded in the Survey Area in July 2021**

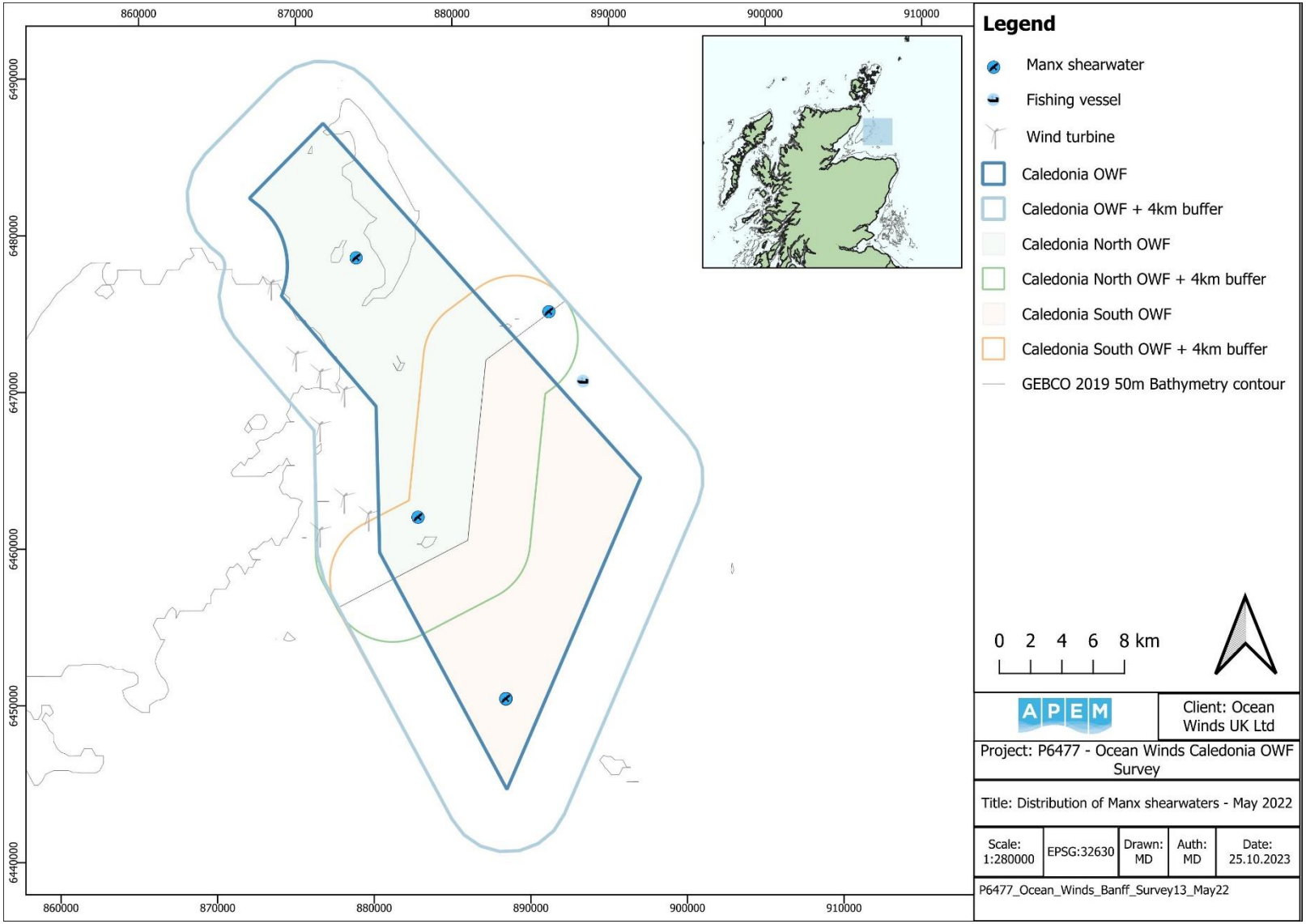



**Figure A4.292 Distribution of Manx shearwaters recorded in the Survey Area in May 2022**

## Unidentified small shearwaters species

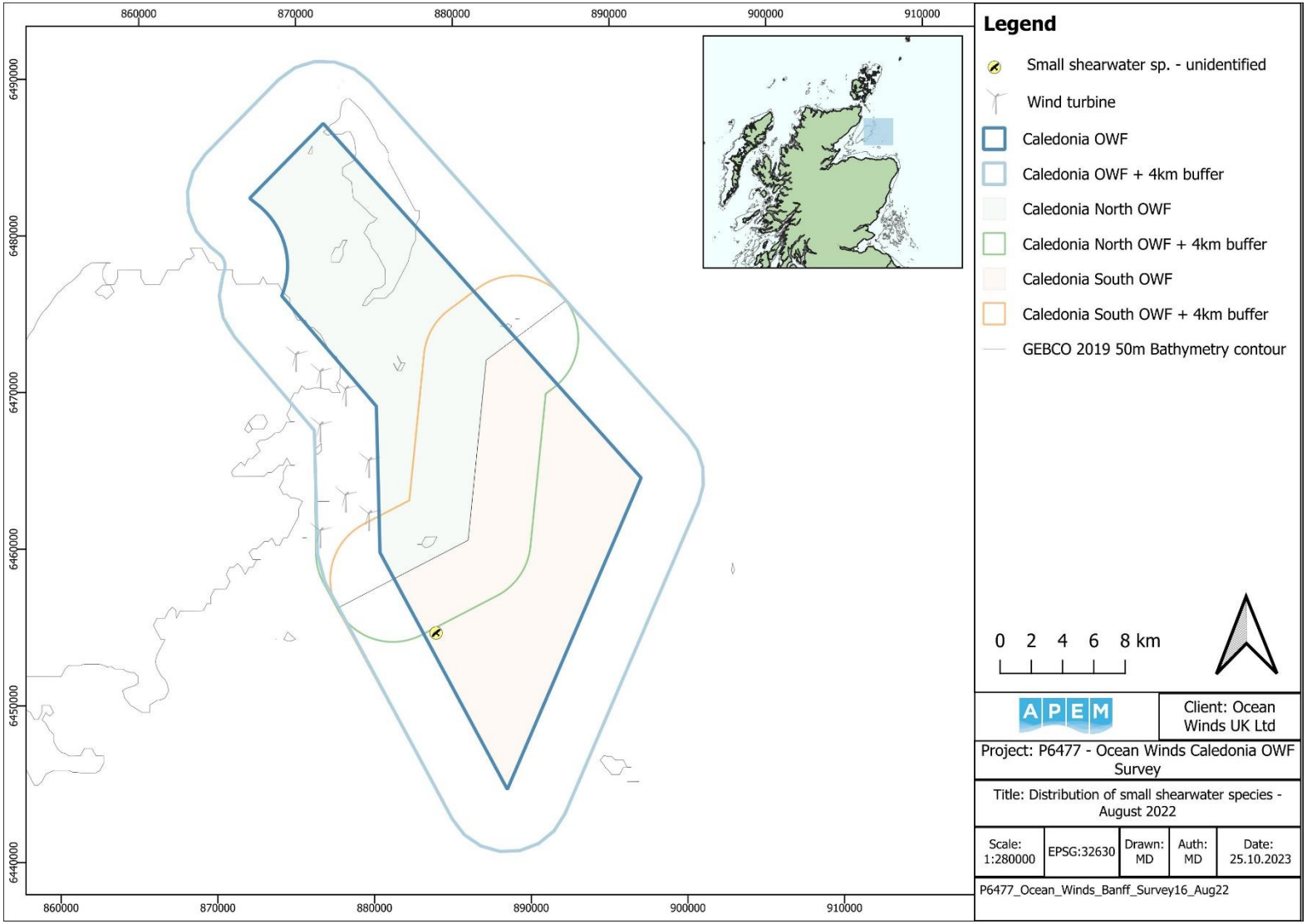



**Figure A4.293 Distribution of small shearwater species recorded in the Survey Area in August 2022**

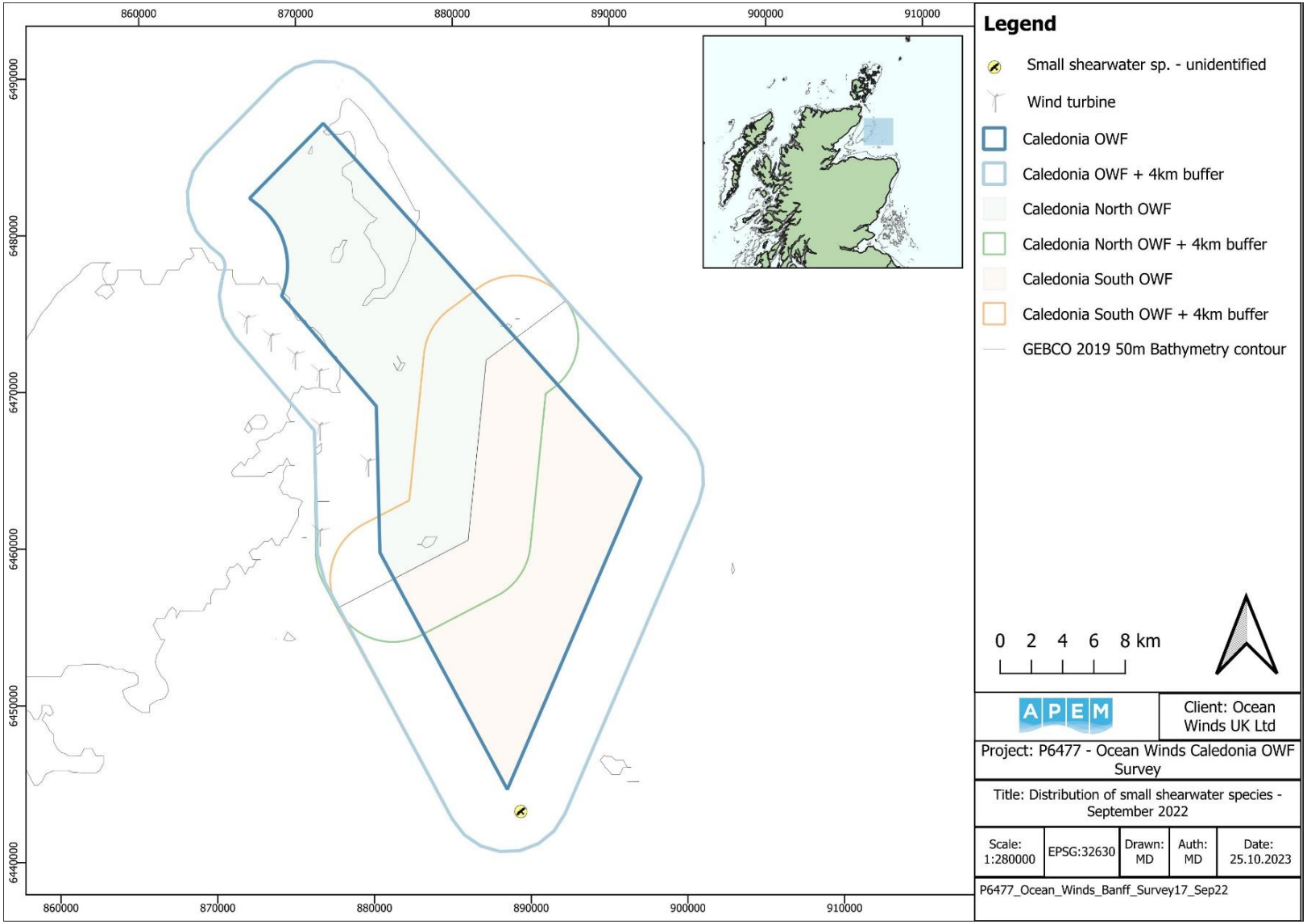



**Figure A4.294 Distribution of small shearwater species recorded in the Survey Area in September 2022**

### Unidentified shearwaters species

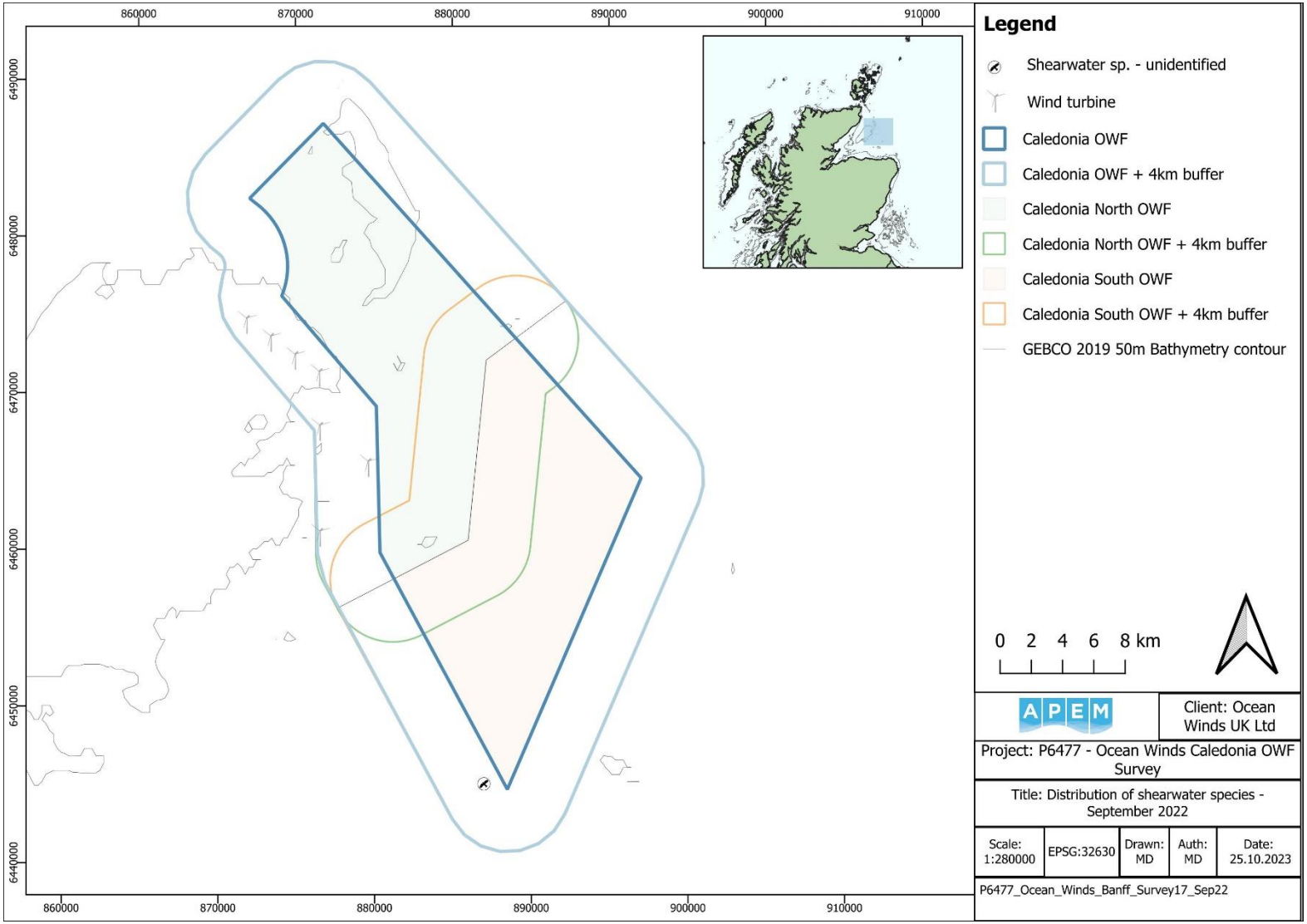



**Figure A4.295 Distribution of shearwater species recorded in the Survey Area in September 2022**

## Unidentified auk and / or shearwaters species

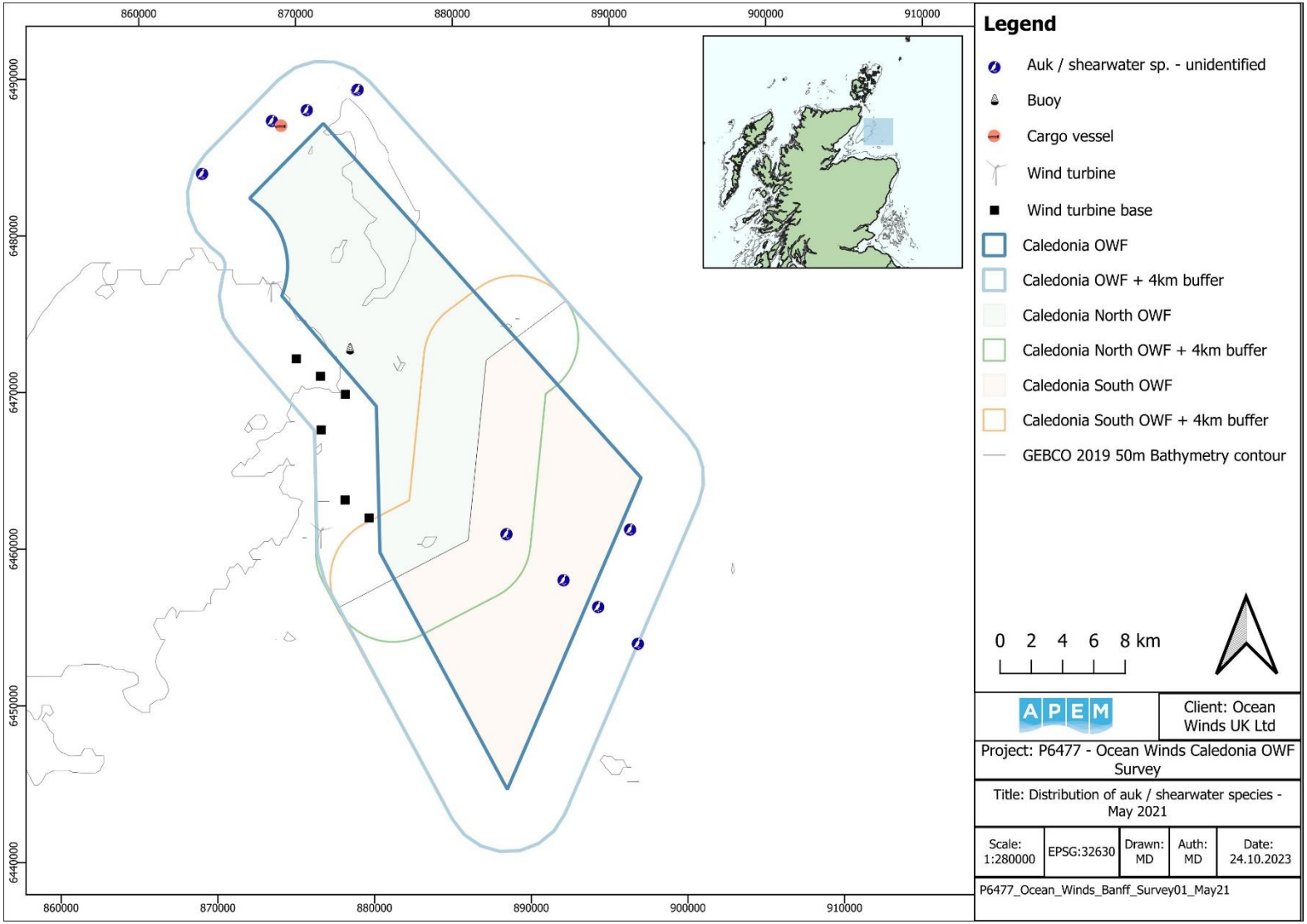



**Figure A4.296 Distribution of auk / shearwater species recorded in the Survey Area in May 2021**

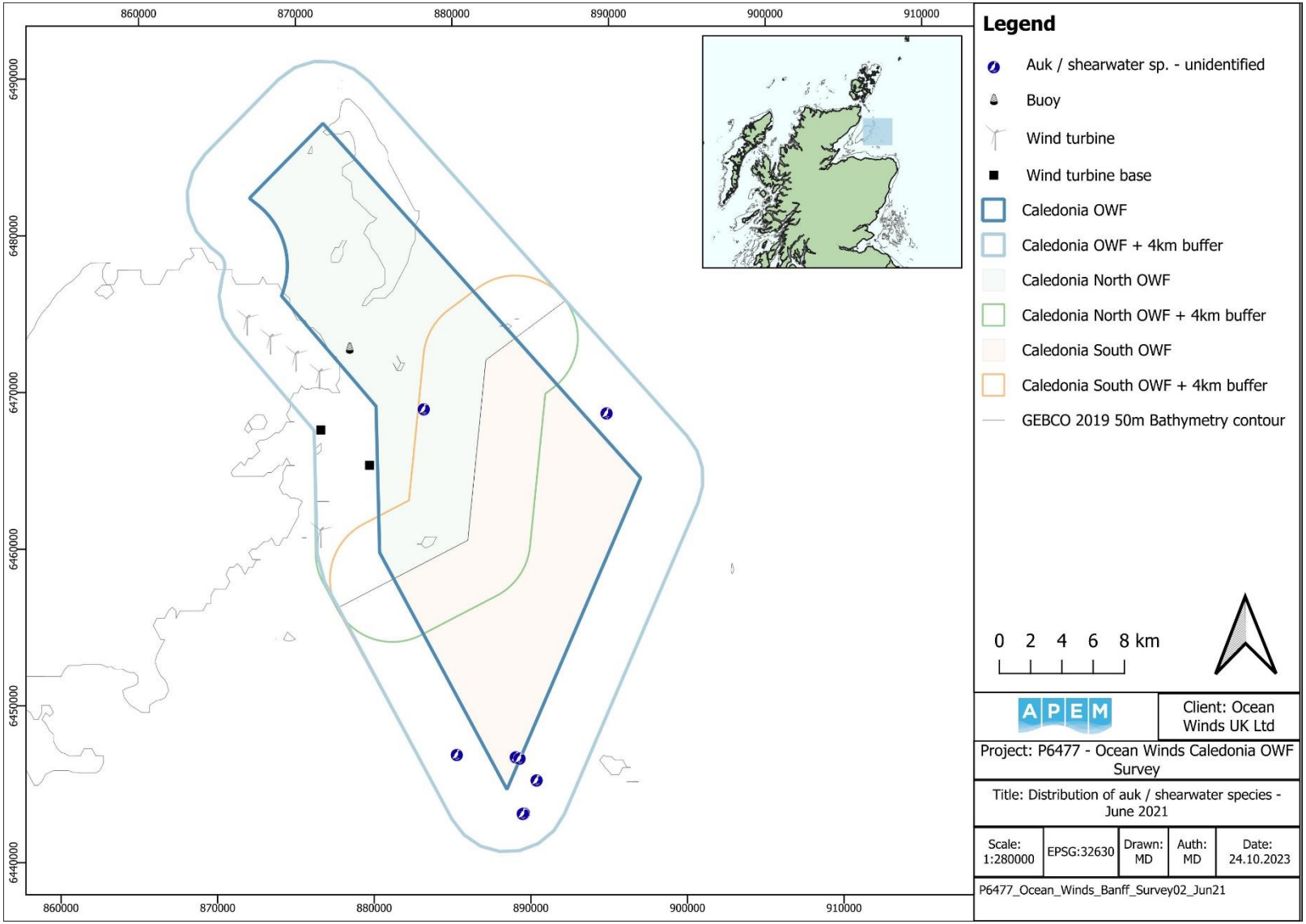



**Figure A4.297 Distribution of auk / shearwater species recorded in the Survey Area in June 2021**

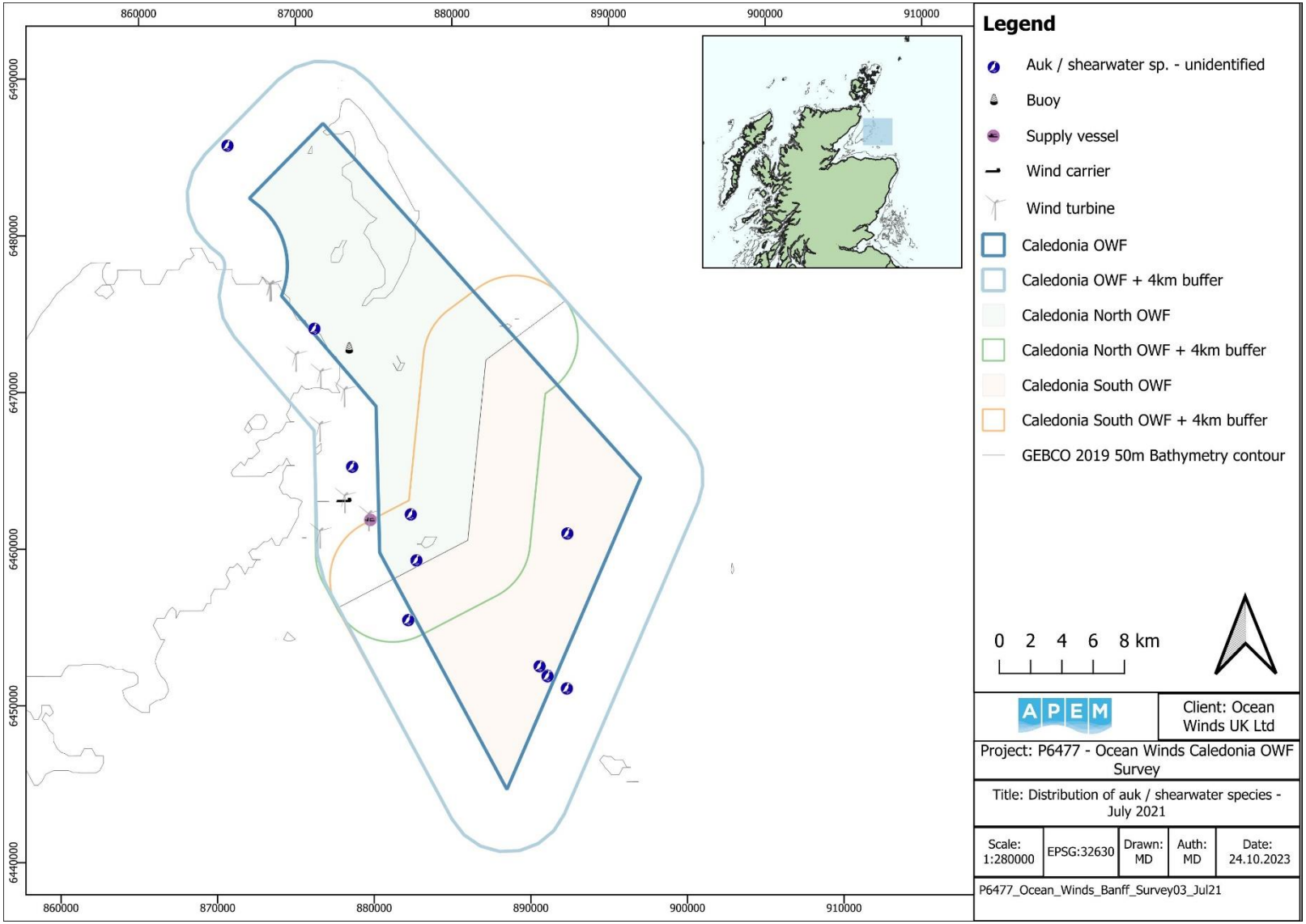



**Figure A4.298 Distribution of auk / shearwater species recorded in the Survey Area in July 2021**

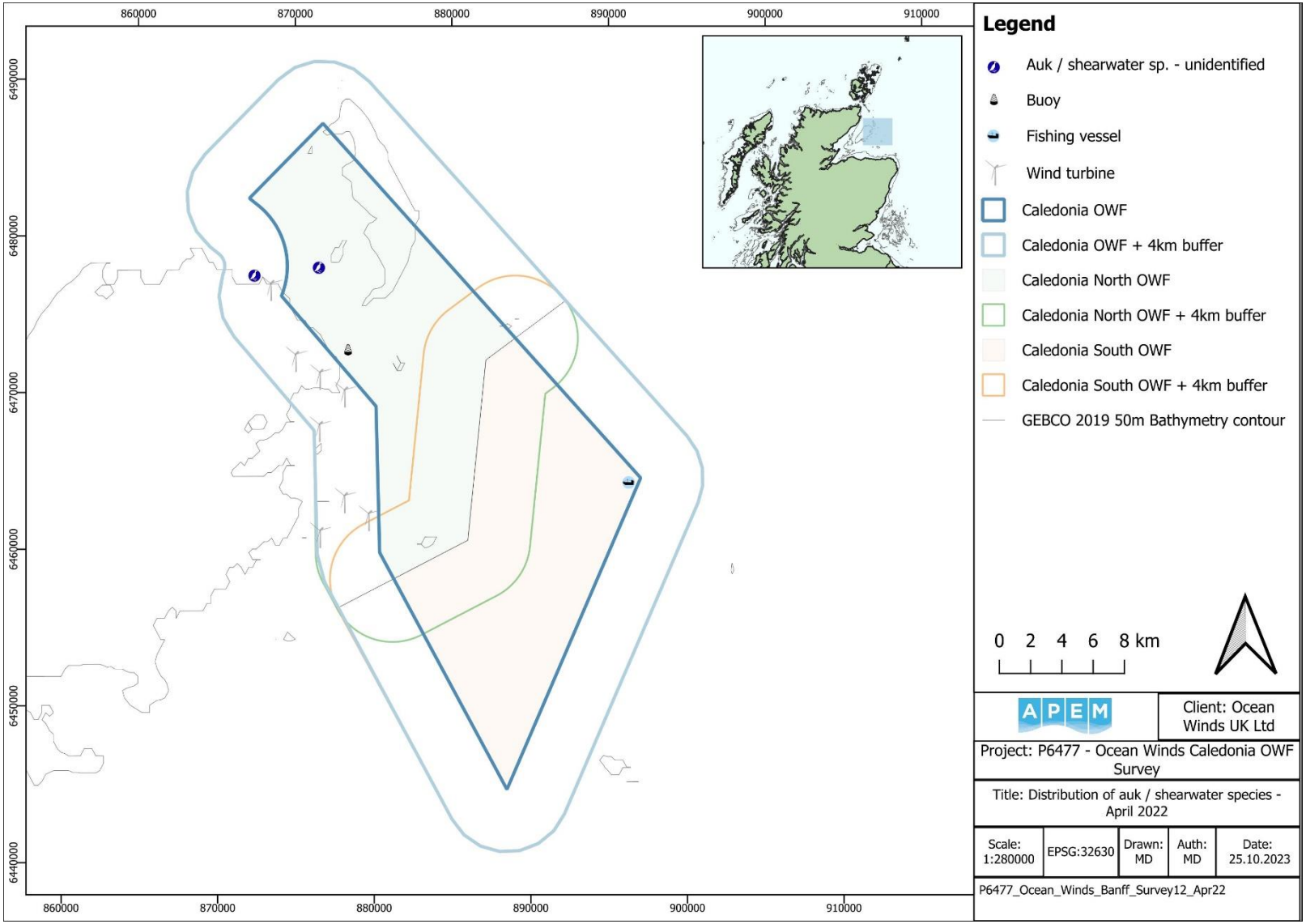



**Figure A4.299 Distribution of auk / shearwater species recorded in the Survey Area in April 2022**

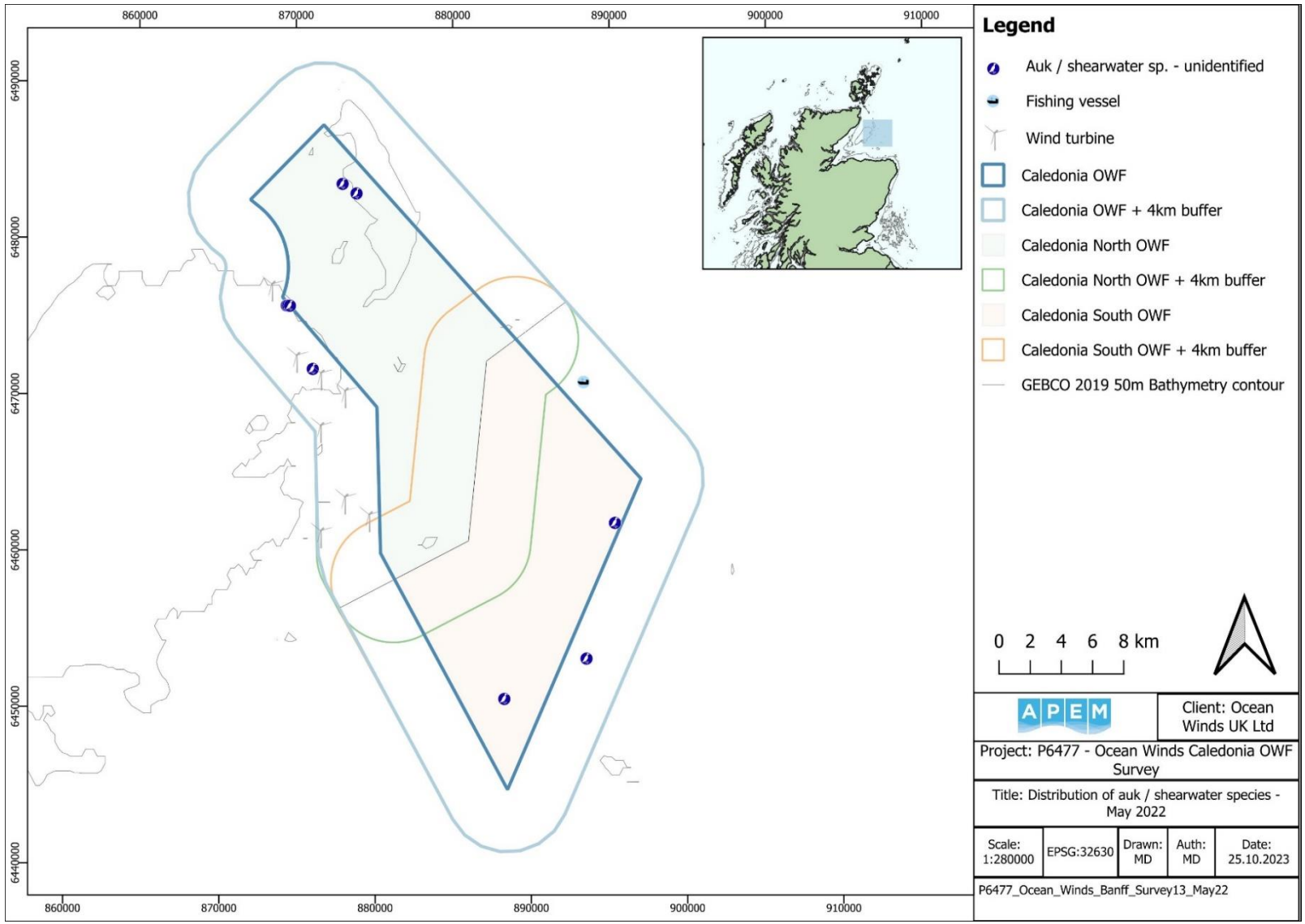



**Figure A4.300 Distribution of auk / shearwater species recorded in the Survey Area in May 2022**

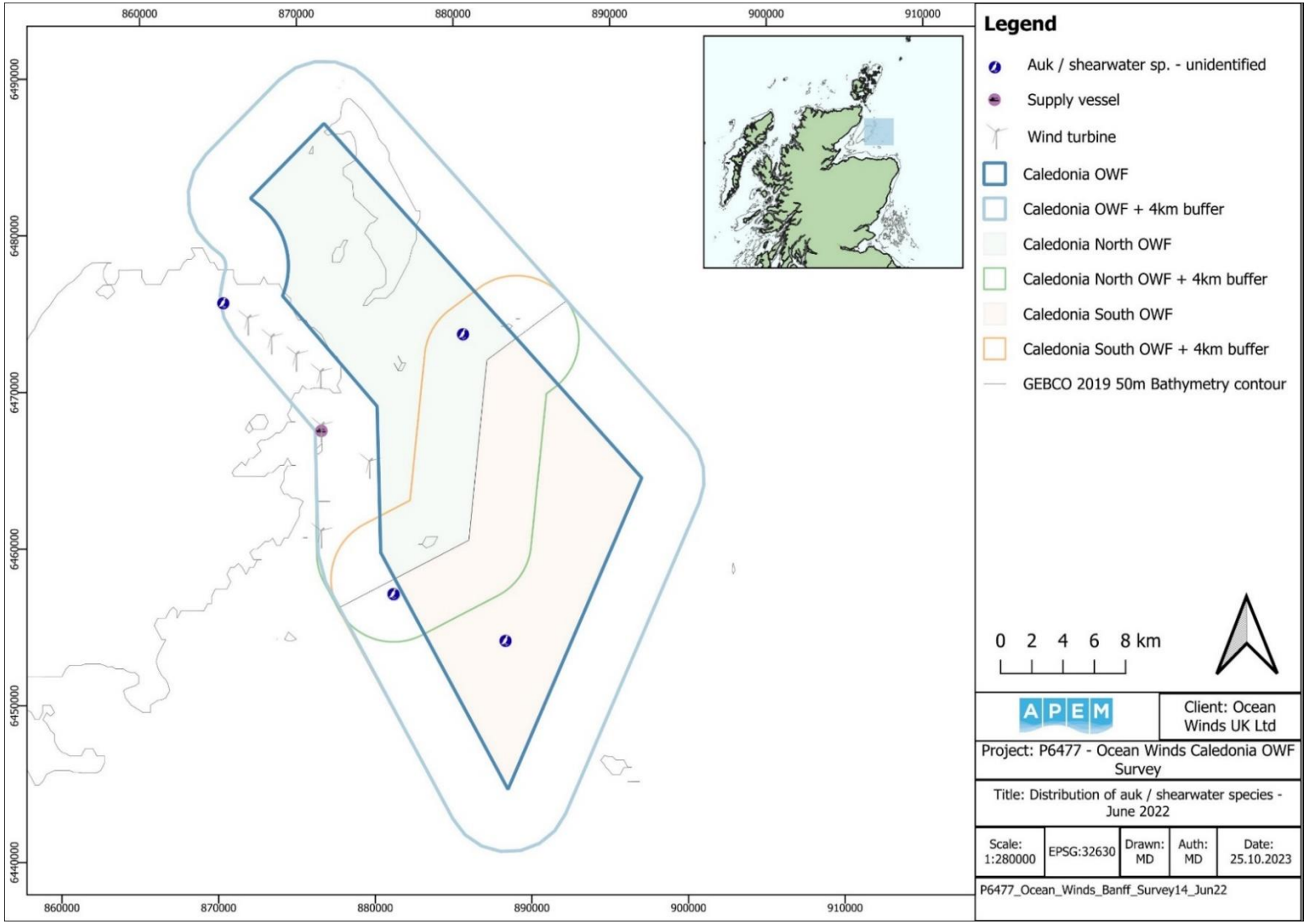



**Figure A4.301 Distribution of auk / shearwater species recorded in the Survey Area in June 2022**

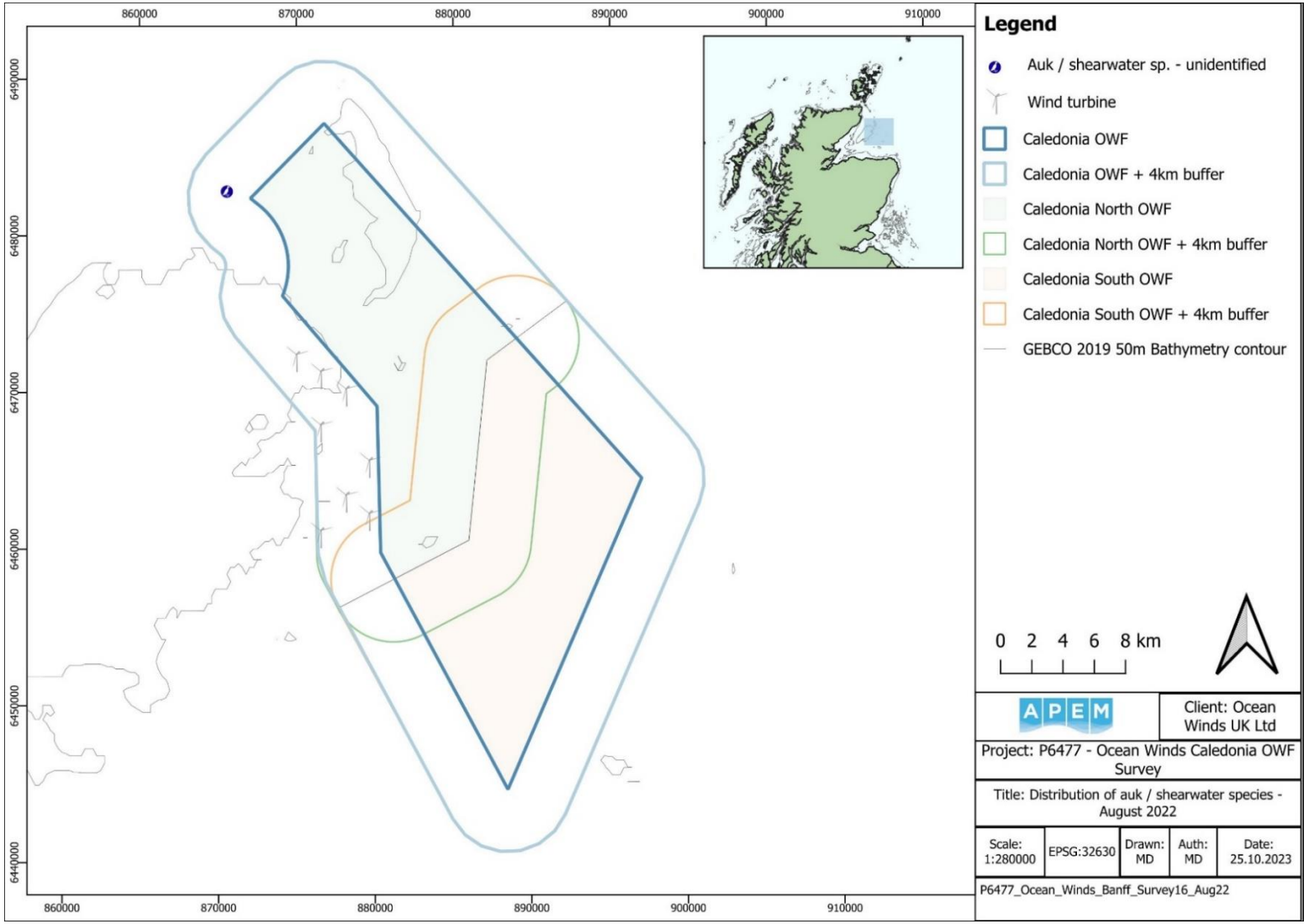



**Figure A4.302 Distribution of auk / shearwater species recorded in the Survey Area in August 2022**

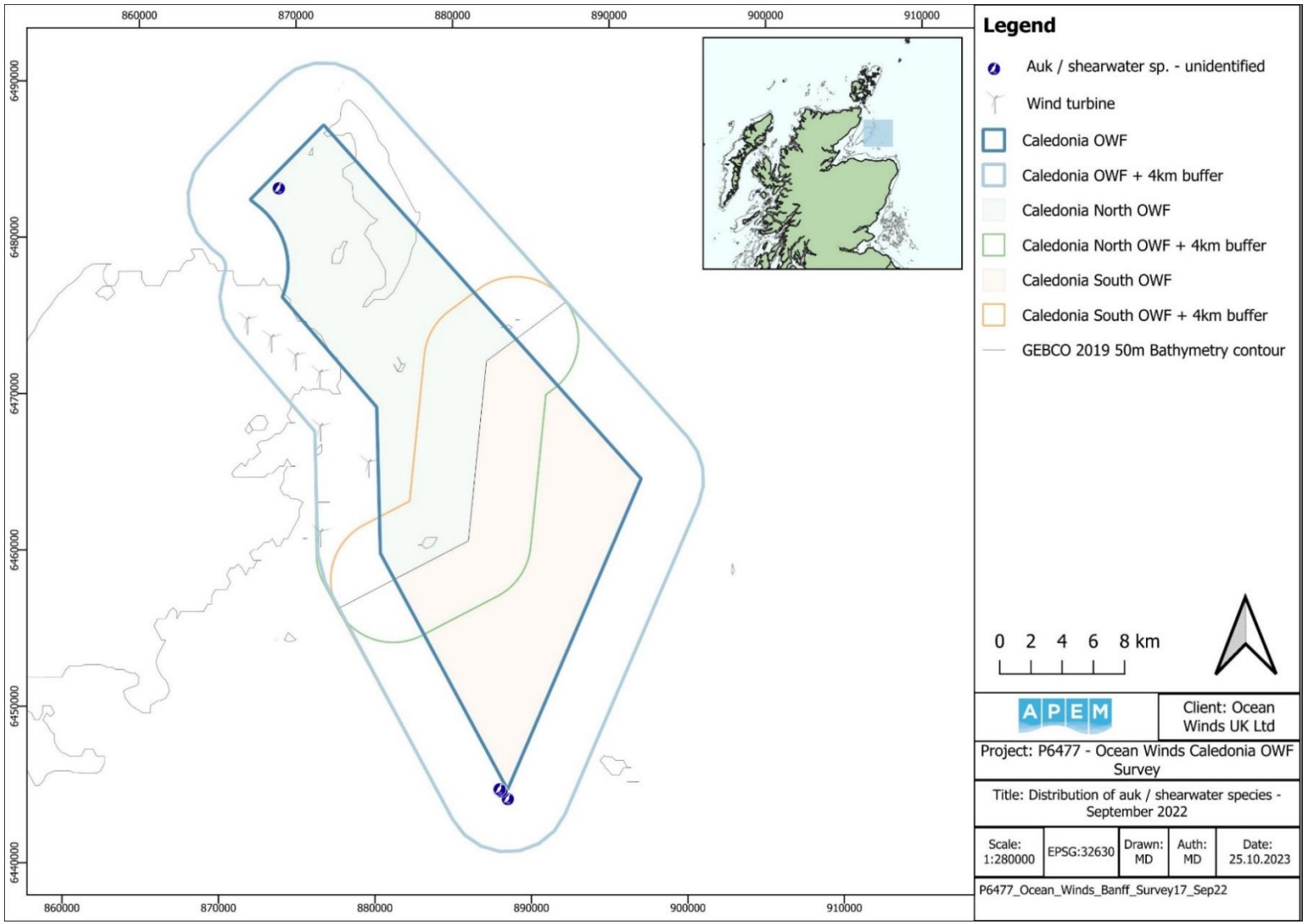



**Figure A4.303 Distribution of auk / shearwater species recorded in the Survey Area in September 2022**

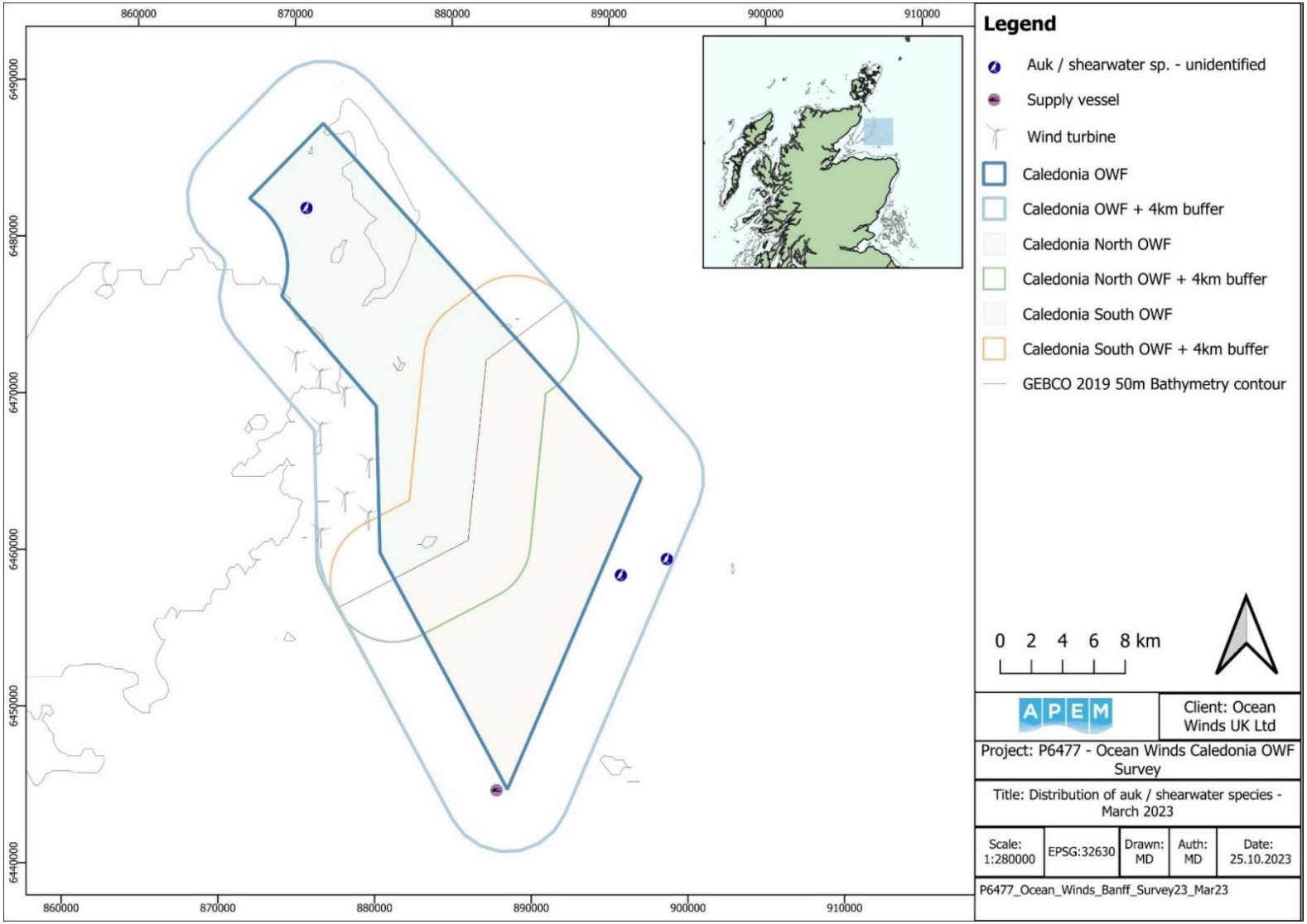



**Figure A4.304 Distribution of auk / shearwater species recorded in the Survey Area in March 2023**

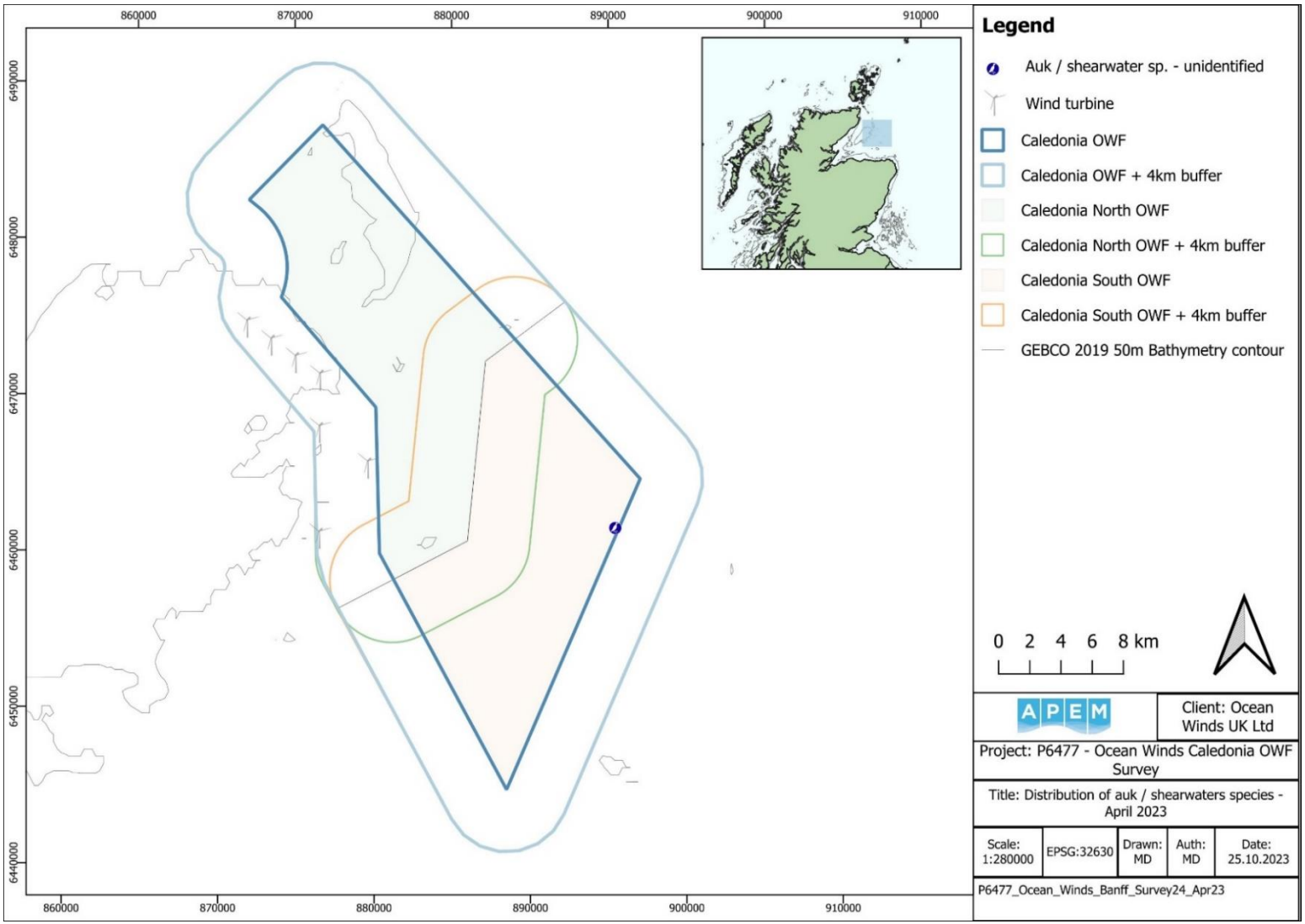



**Figure A4.305 Distribution of auk / shearwater species recorded in the Survey Area in April 2023**

## Gannet

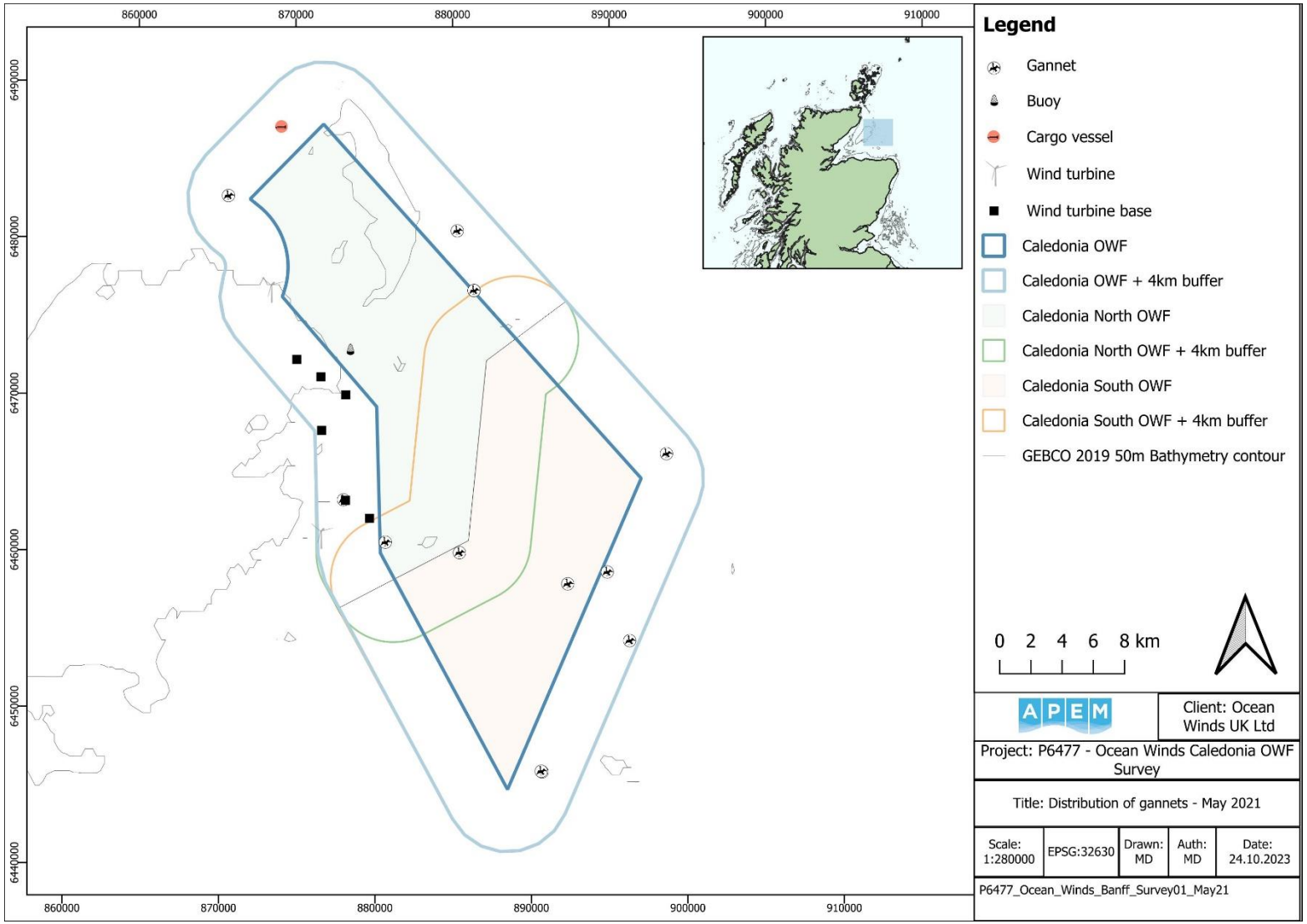



**Figure A4.306 Distribution of gannets recorded in the Survey Area in May 2021**

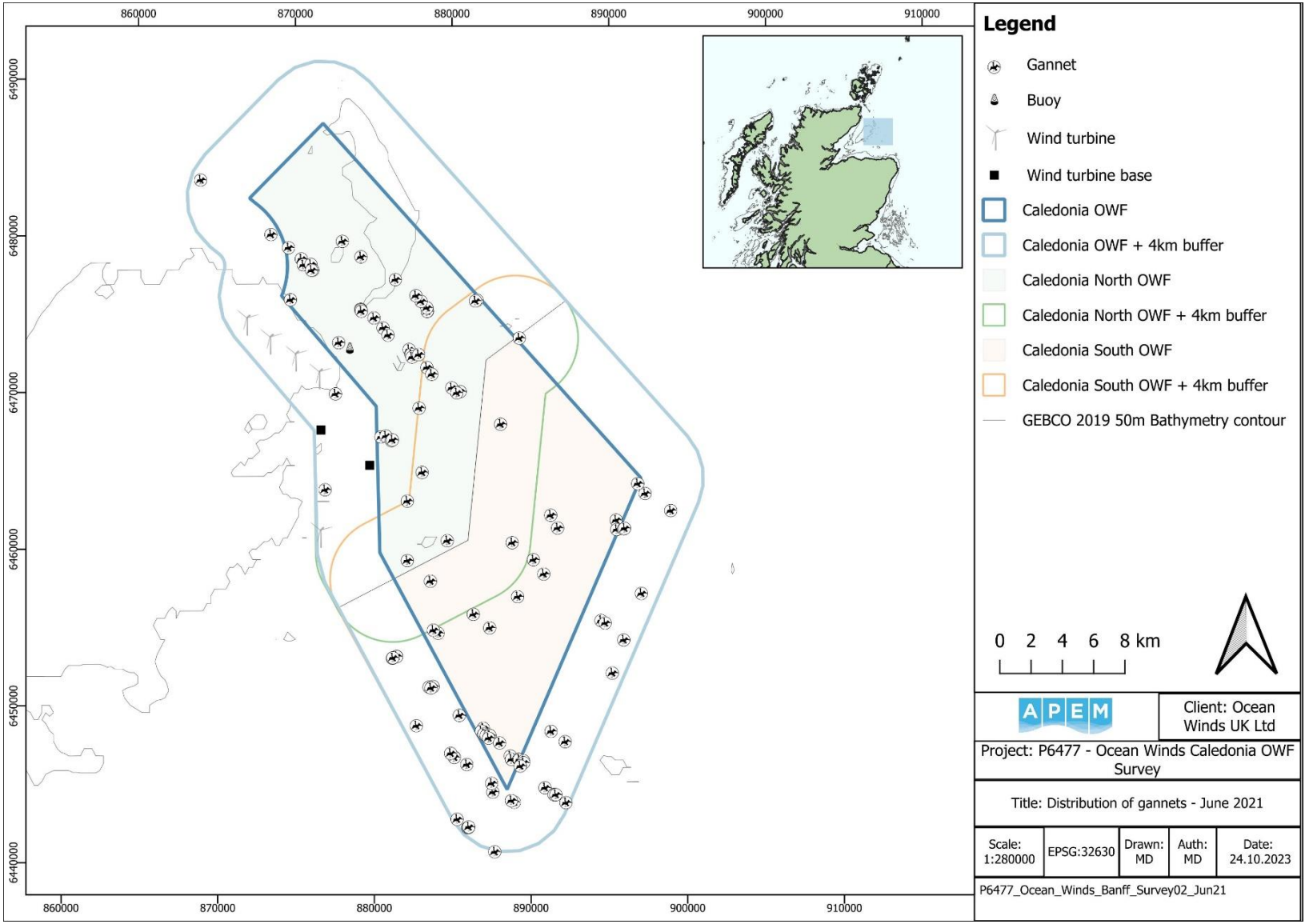



**Figure A4.307 Distribution of gannets recorded in the Survey Area in June 2021**

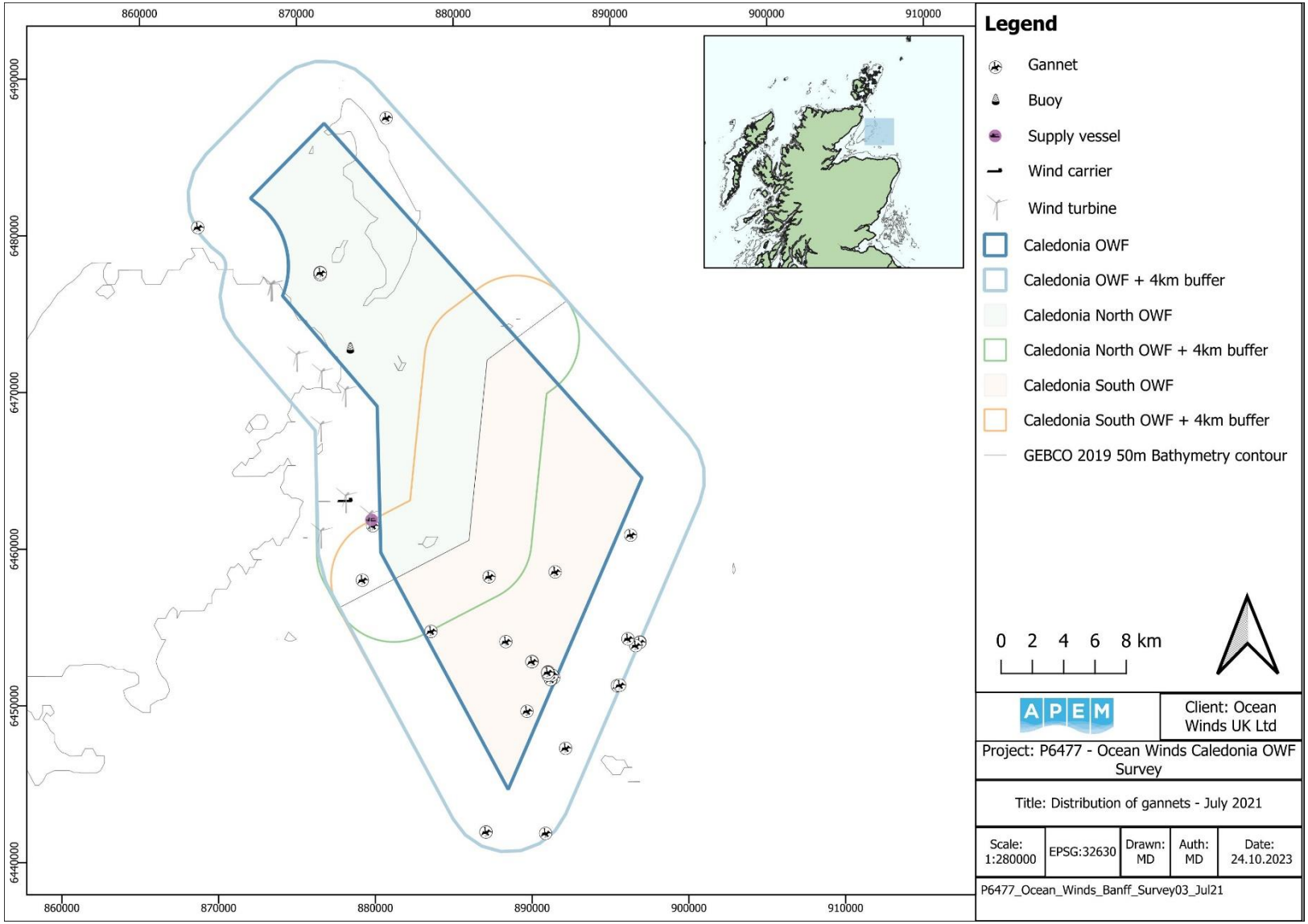



**Figure A4.308 Distribution of gannets recorded in the Survey Area in July 2021**

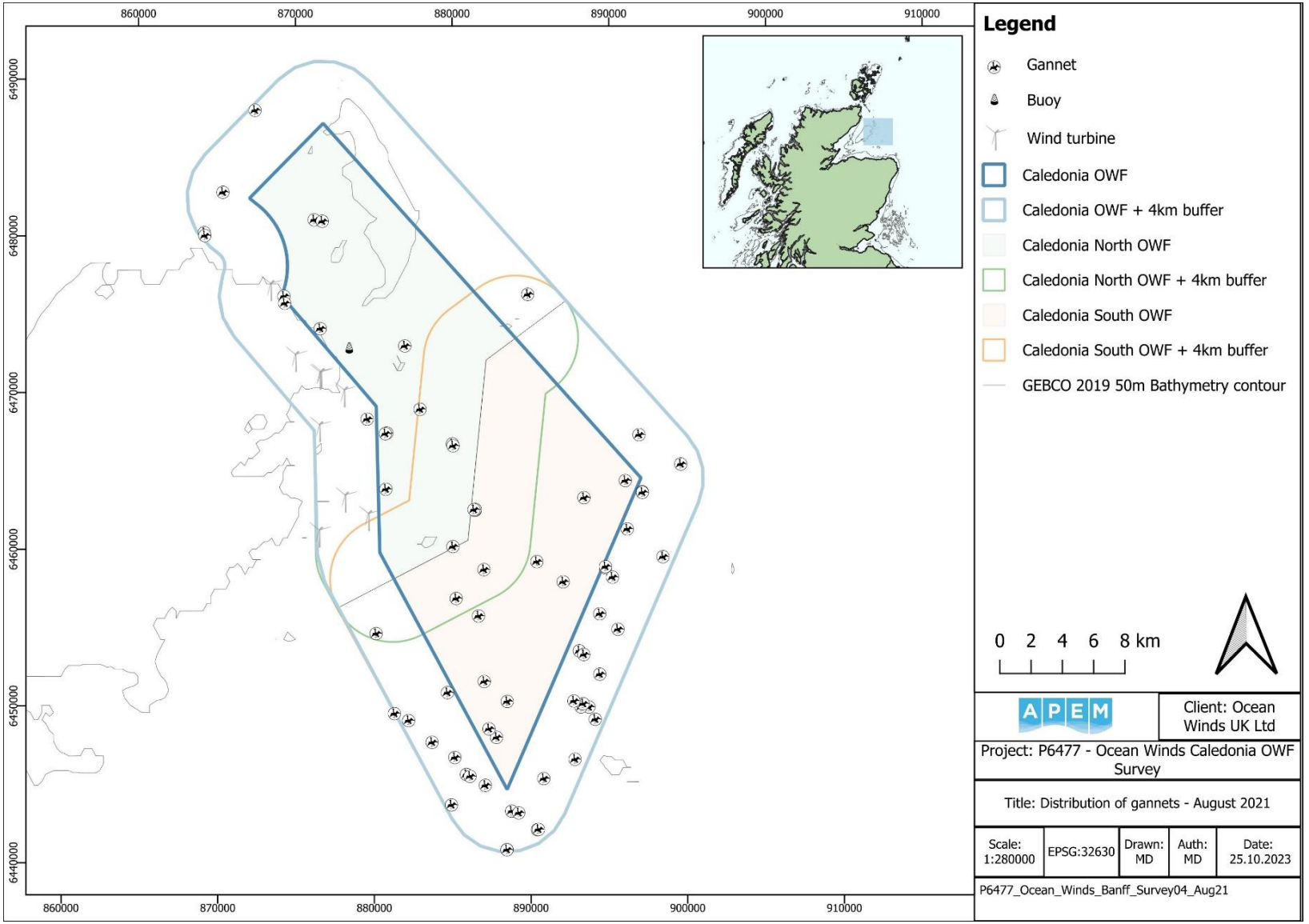



**Figure A4.309 Distribution of gannets recorded in the Survey Area in August 2021**

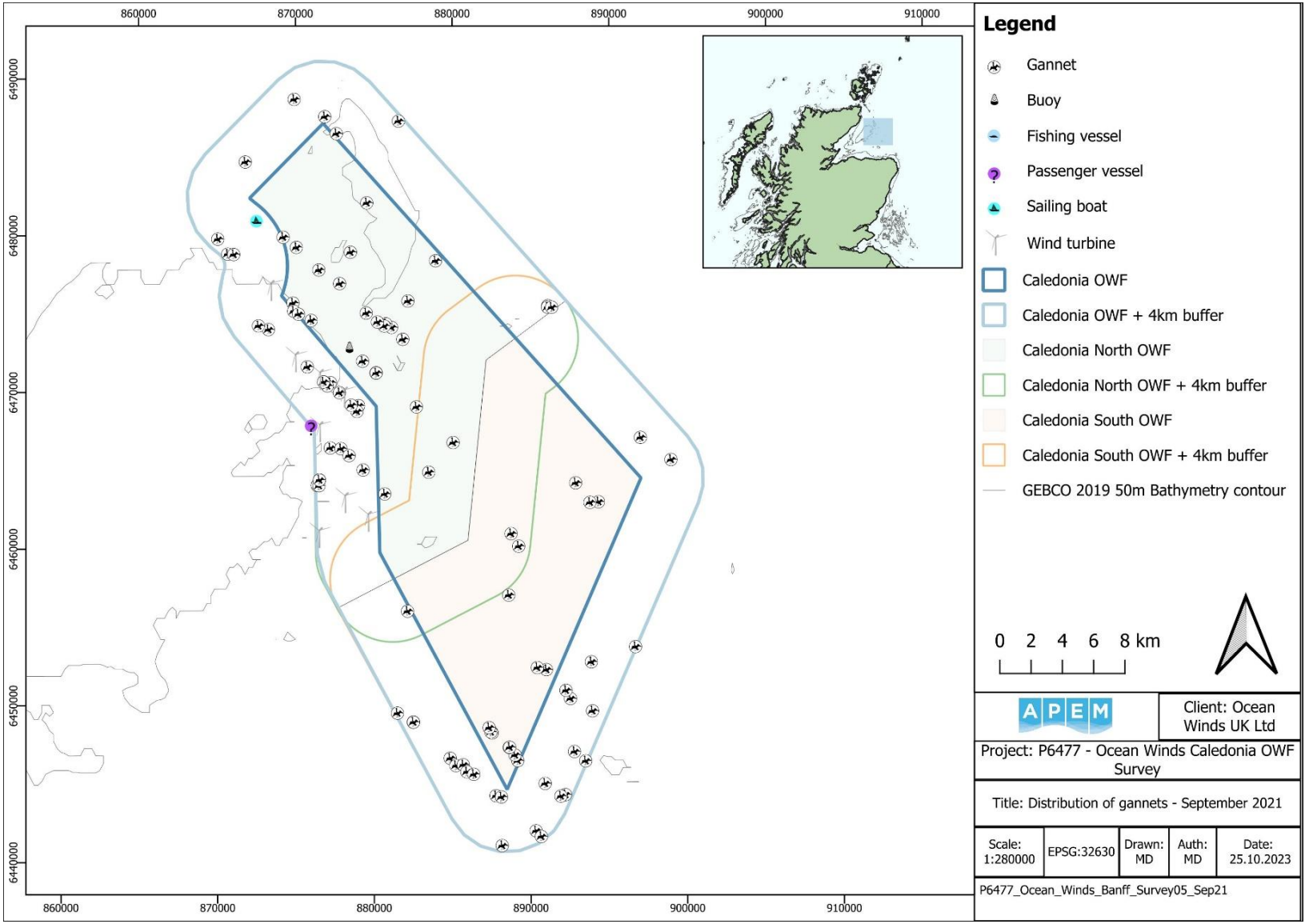



**Figure A4.310 Distribution of gannets recorded in the Survey Area in September 2021**

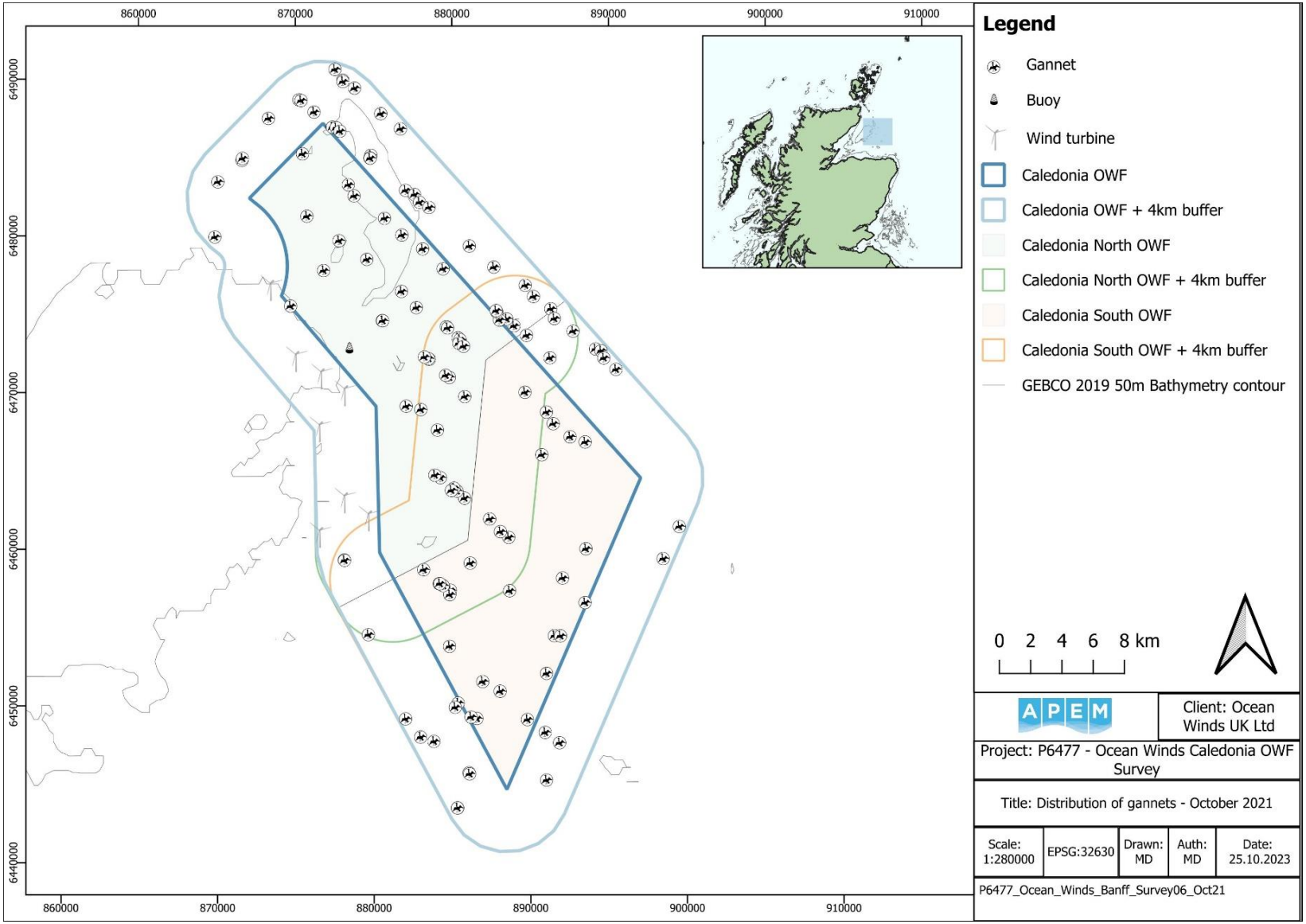



**Figure A4.311 Distribution of gannets recorded in the Survey Area in October 2021**

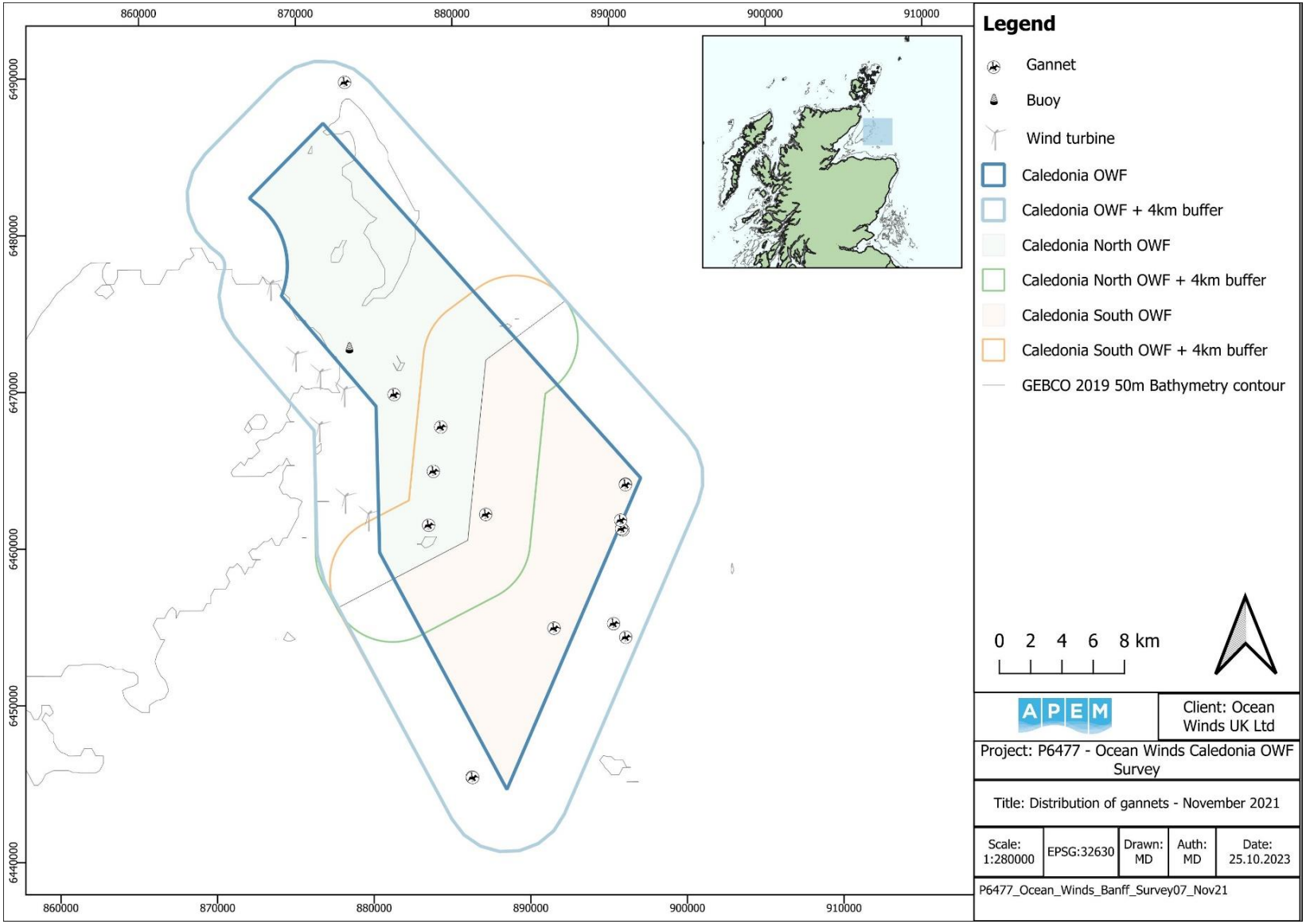



**Figure A4.312 Distribution of gannets recorded in the Survey Area in November 2021**

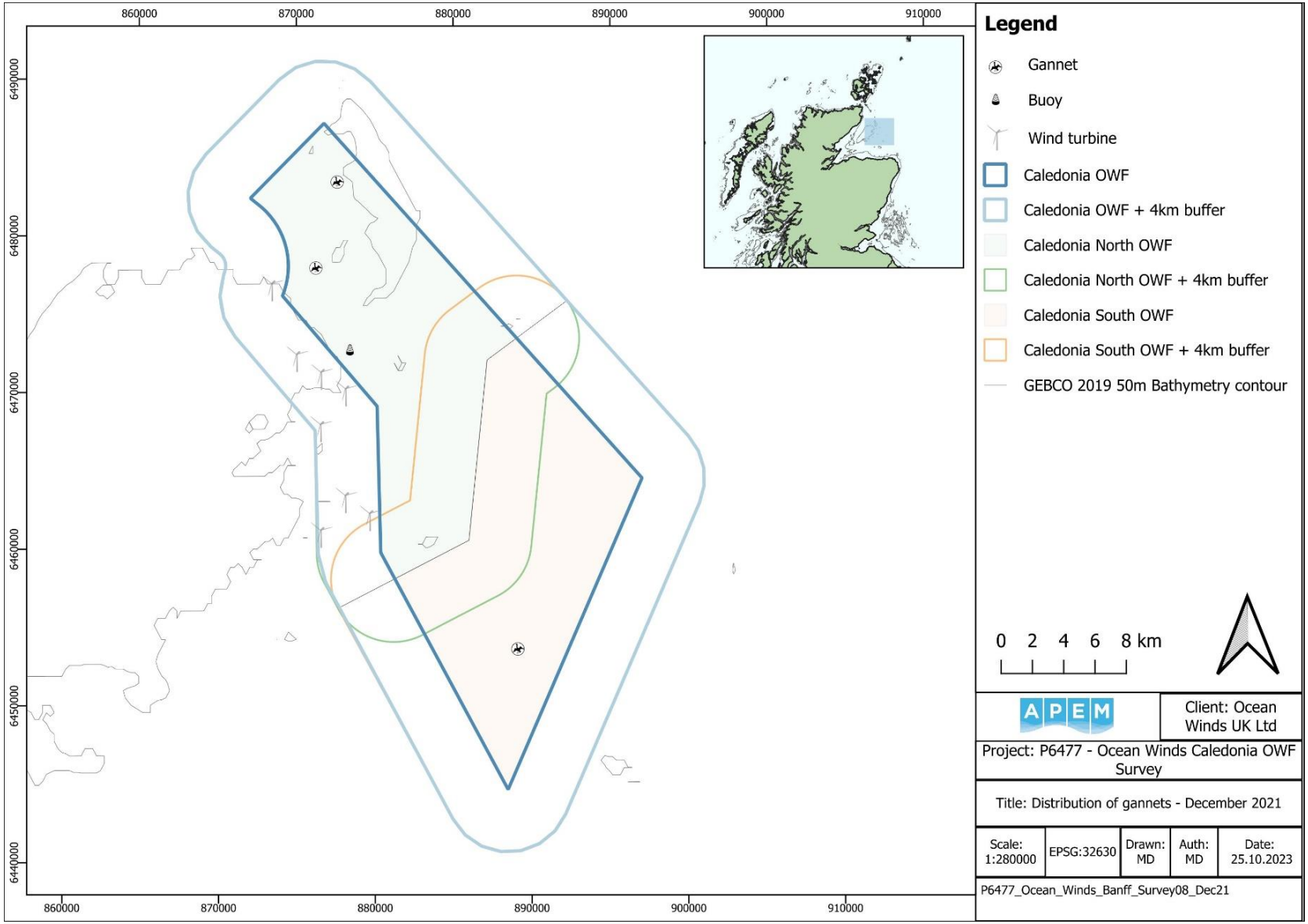



**Figure A4.313 Distribution of gannets recorded in the Survey Area in December 2021**

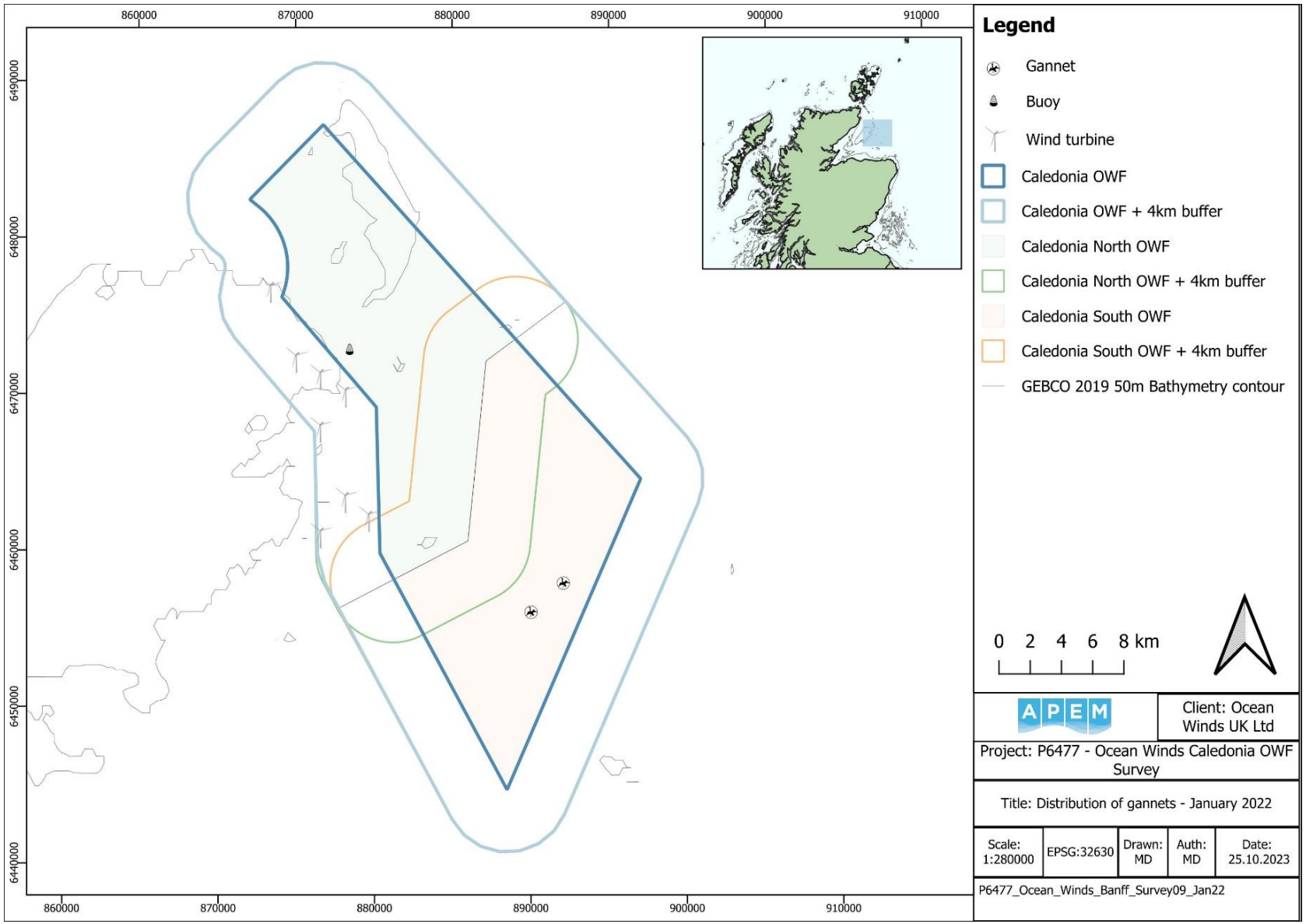



**Figure A4.314 Distribution of gannets recorded in the Survey Area in January 2022**

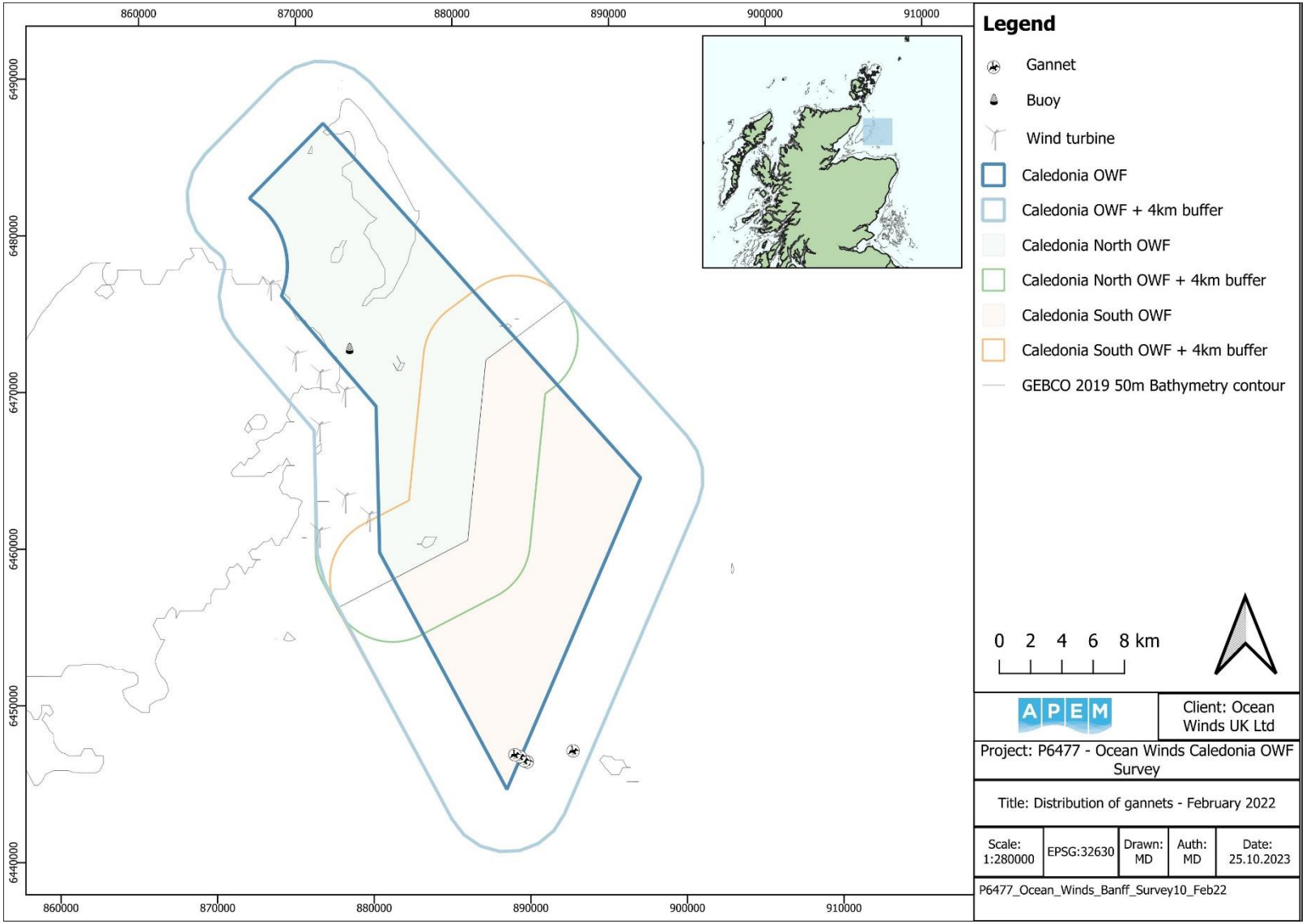



**Figure A4.315 Distribution of gannets recorded in the Survey Area in February 2022**

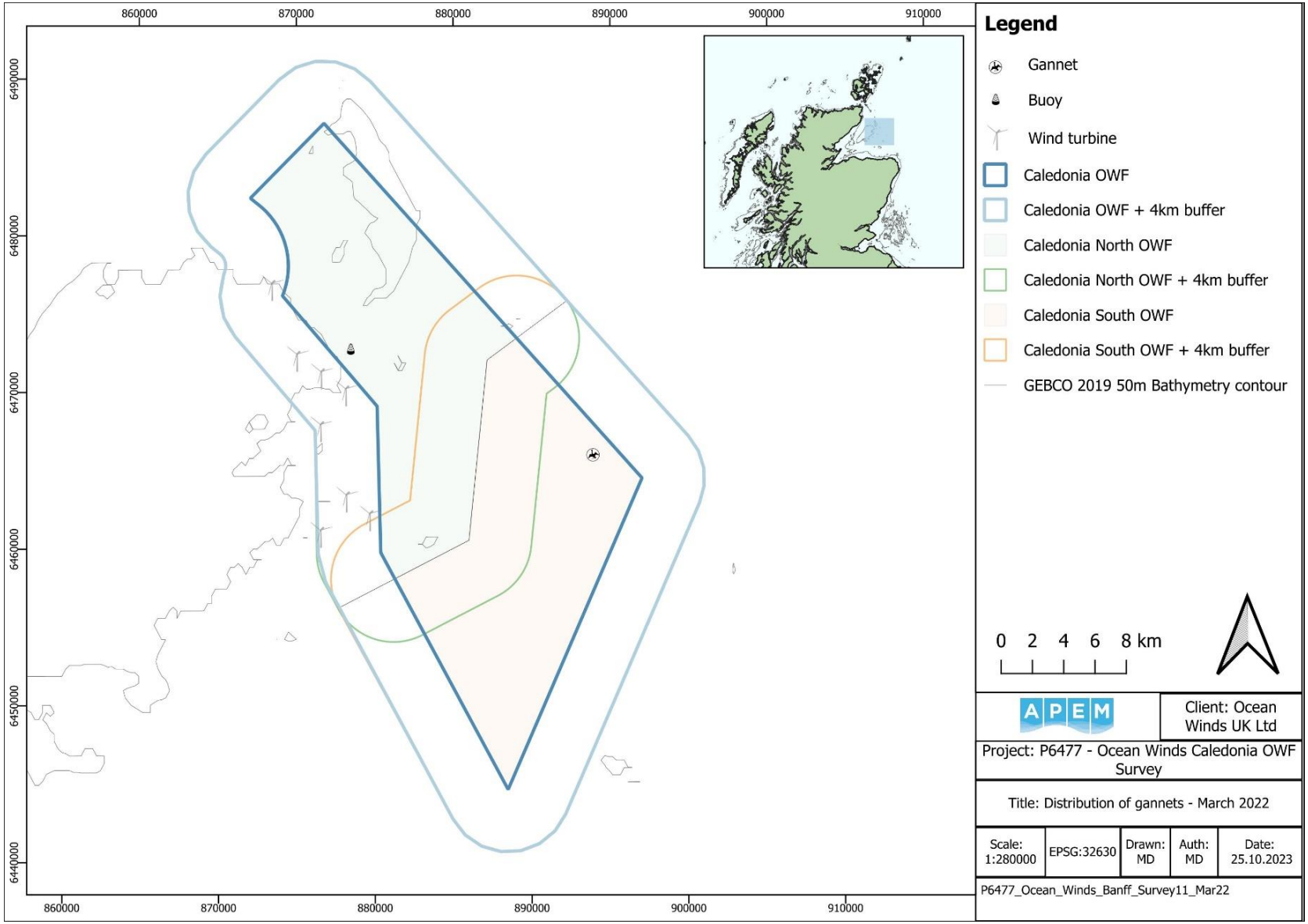



**Figure A4.316 Distribution of gannets recorded in the Survey Area in March 2022**

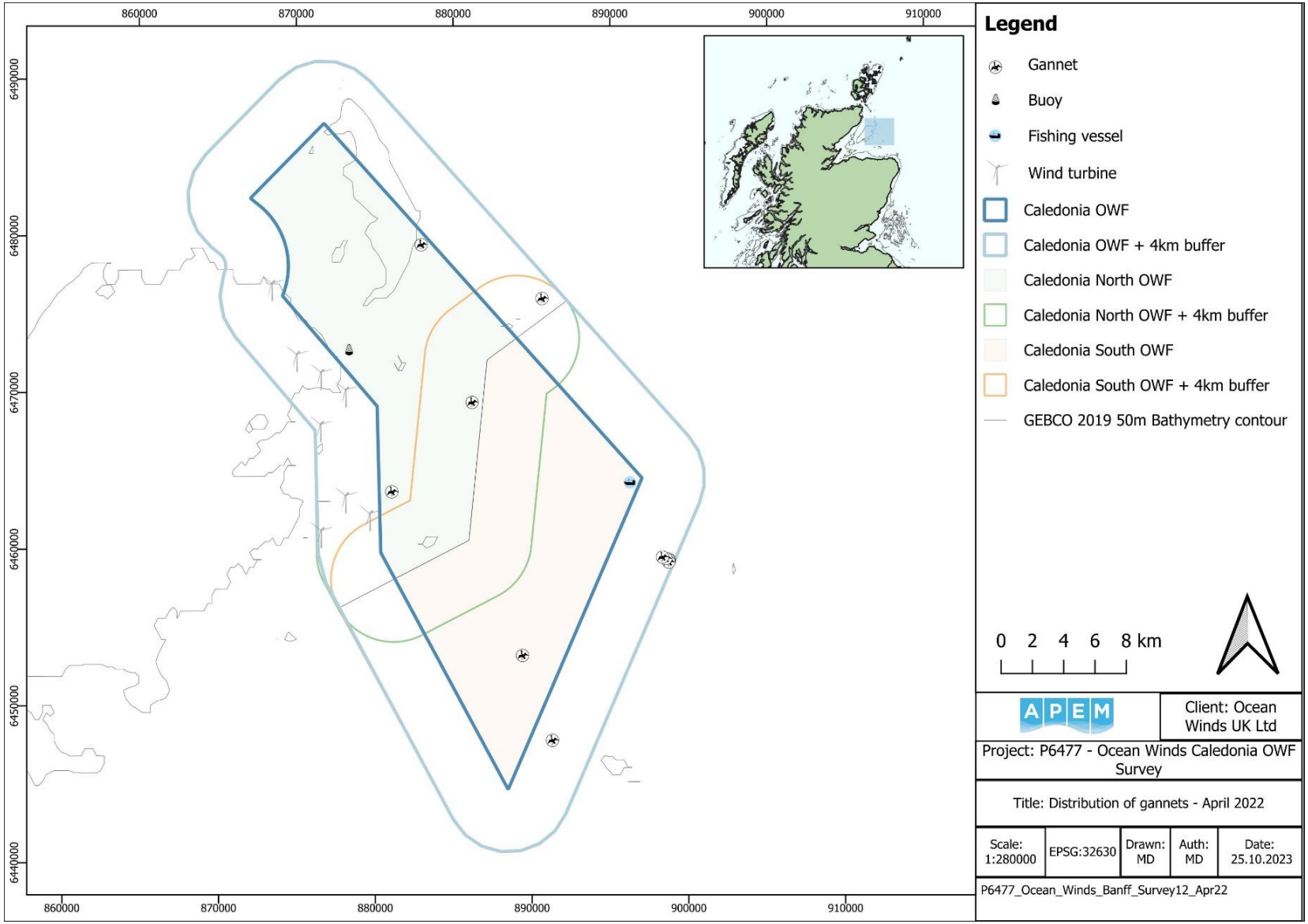



**Figure A4.317 Distribution of gannets recorded in the Survey Area in April 2022**

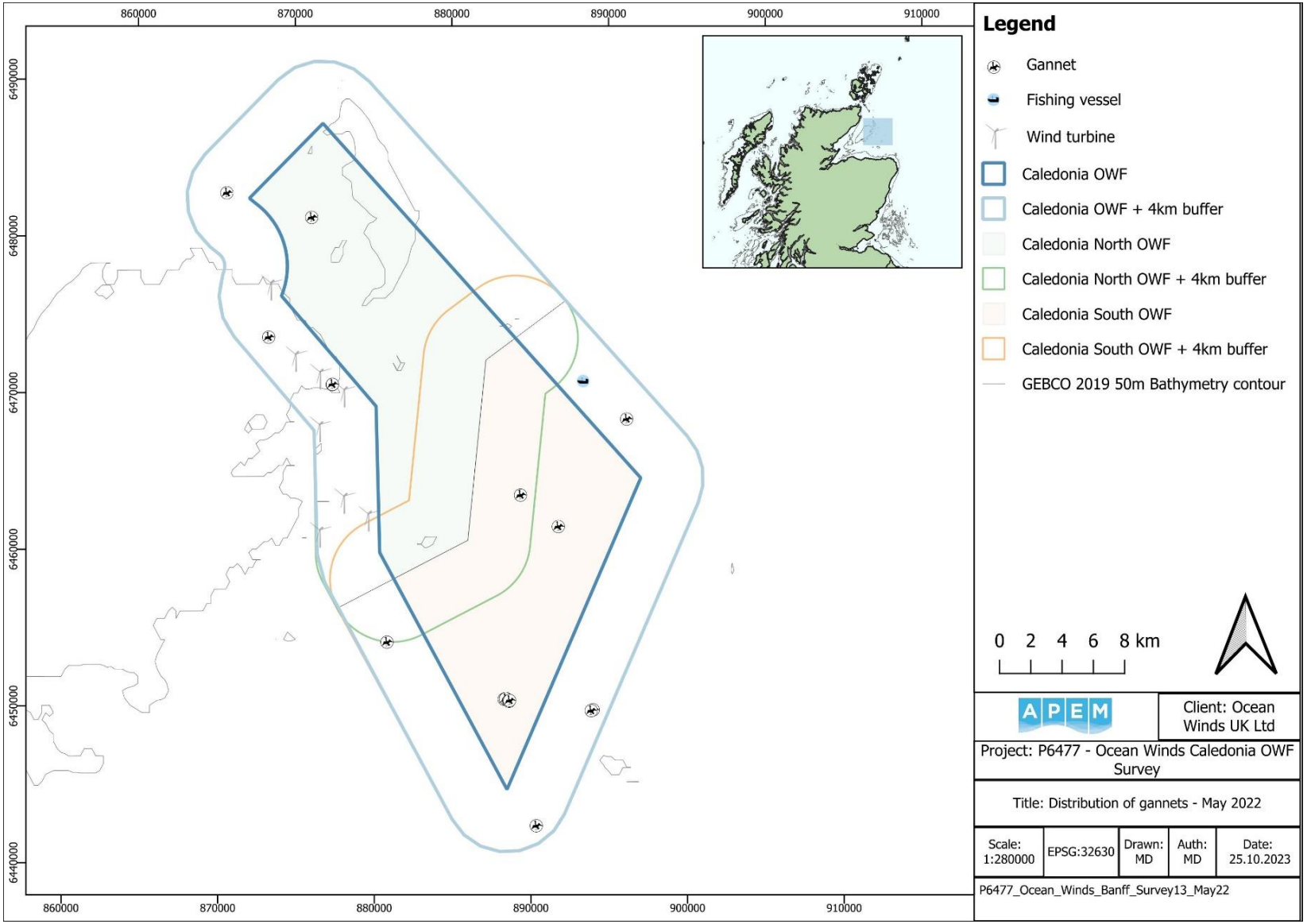



**Figure A4.318 Distribution of gannets recorded in the Survey Area in May 2022**

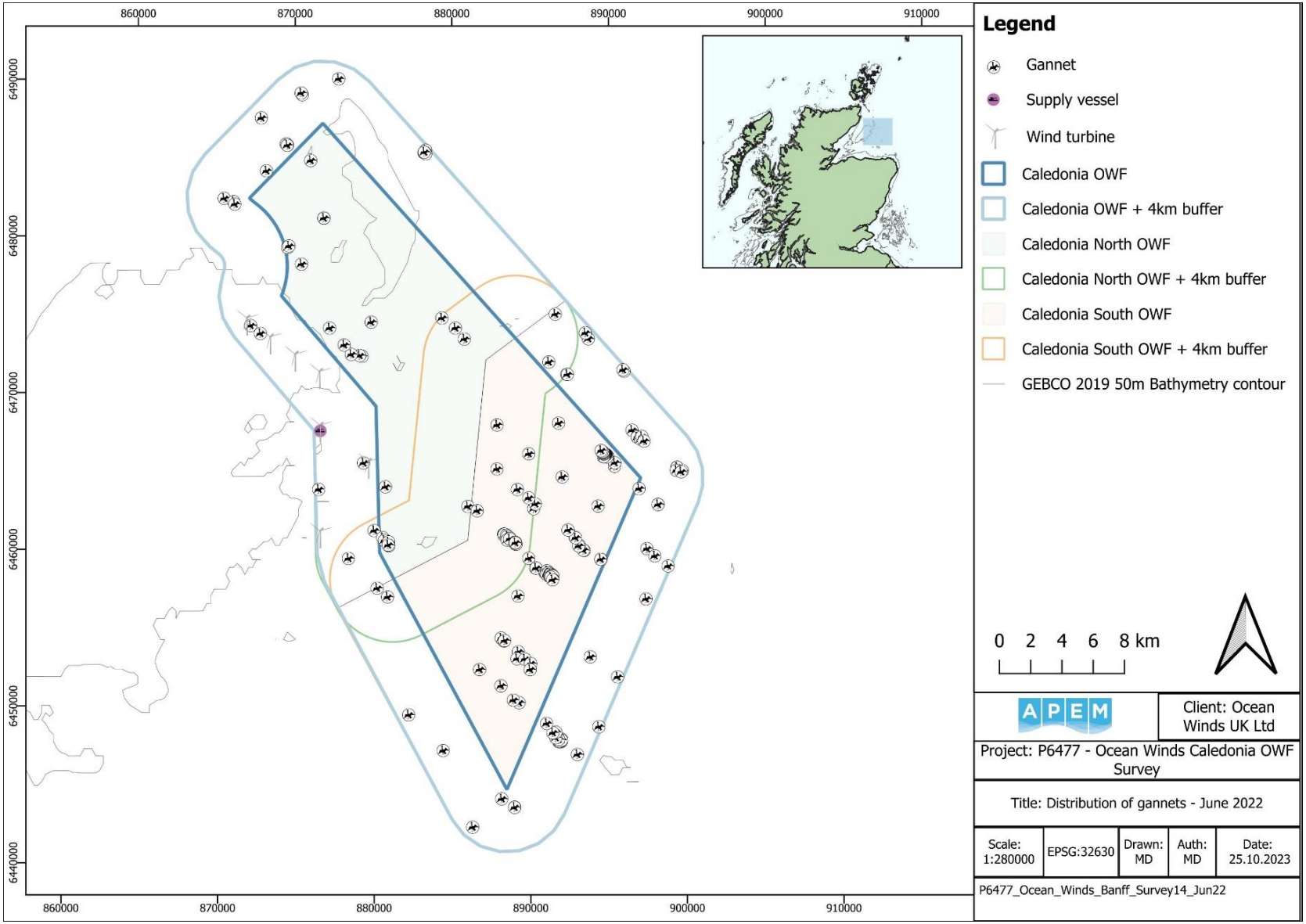



**Figure A4.319 Distribution of gannets recorded in the Survey Area in June 2022**

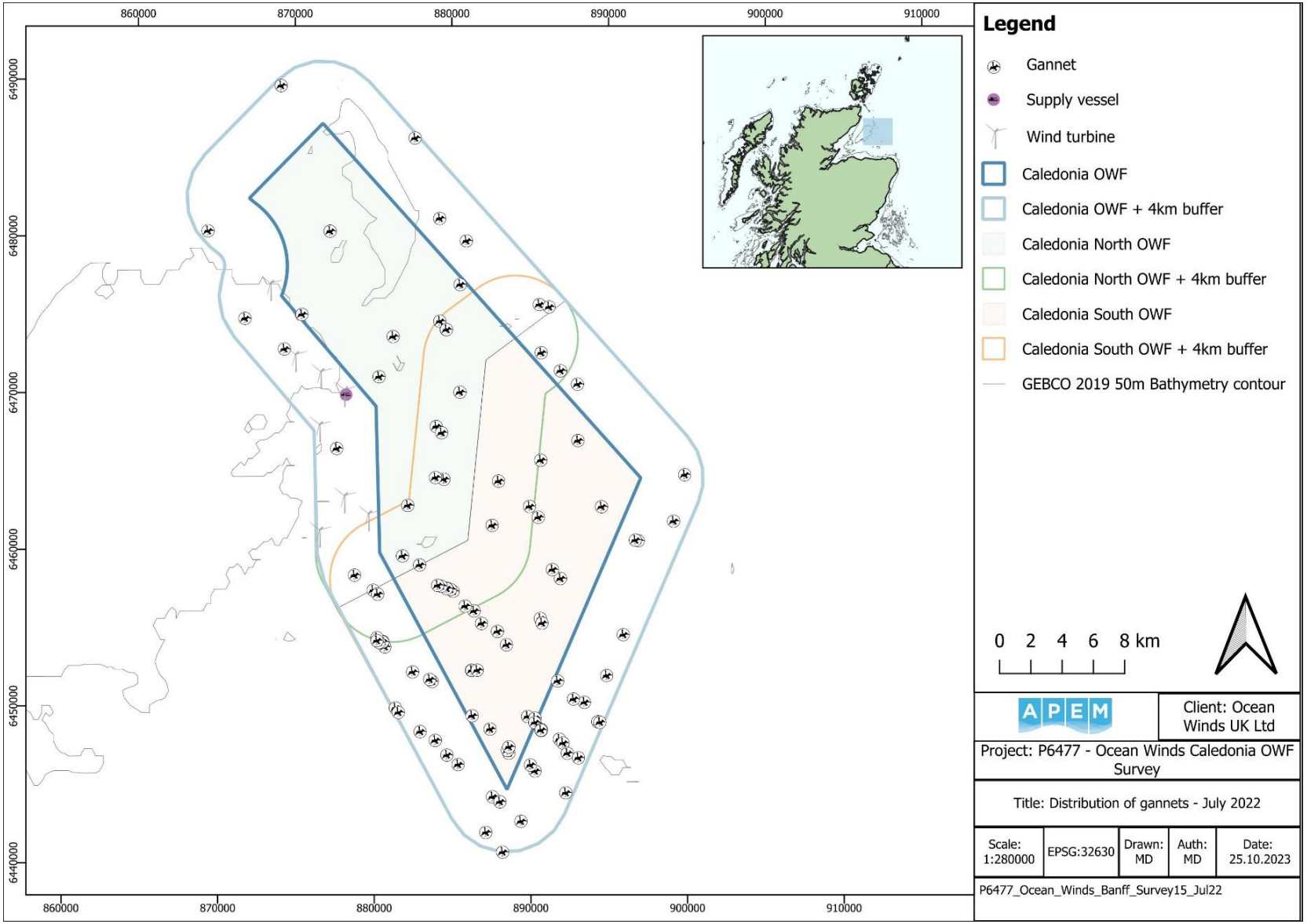



**Figure A4.320 Distribution of gannets recorded in the Survey Area in July 2022**

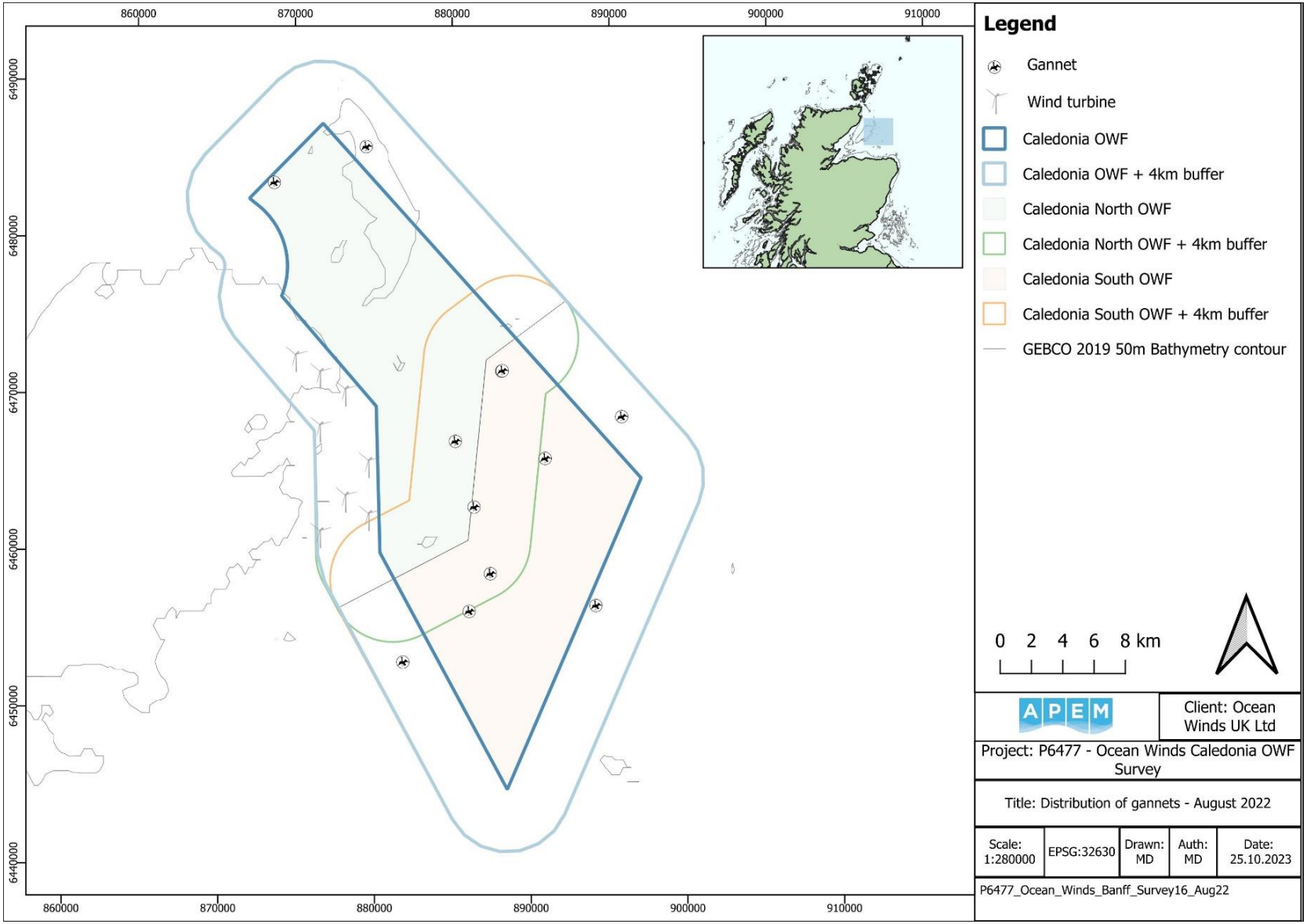



**Figure A4.321 Distribution of gannets recorded in the Survey Area in August 2022**

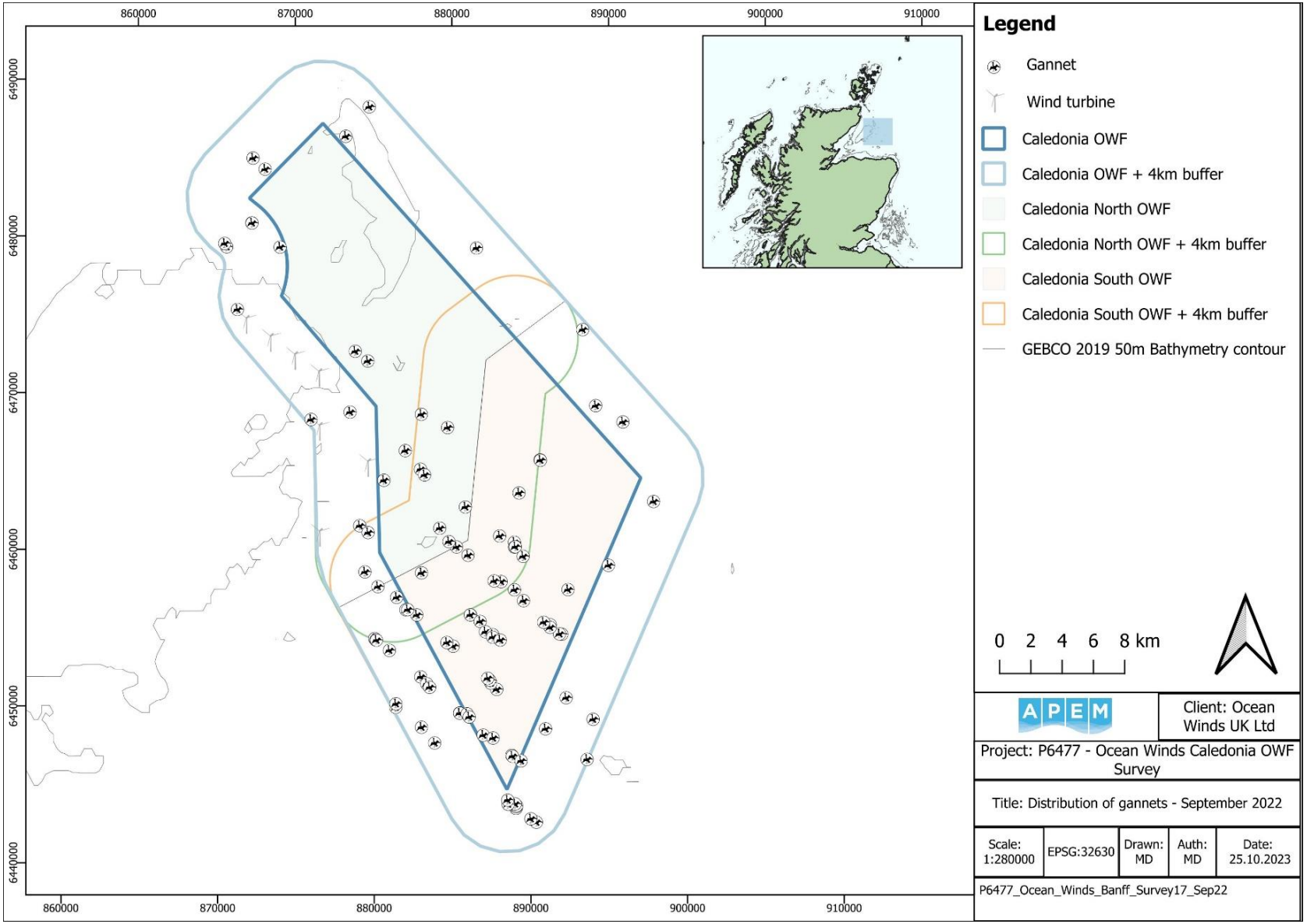



**Figure A4.322 Distribution of gannets recorded in the Survey Area in September 2022**

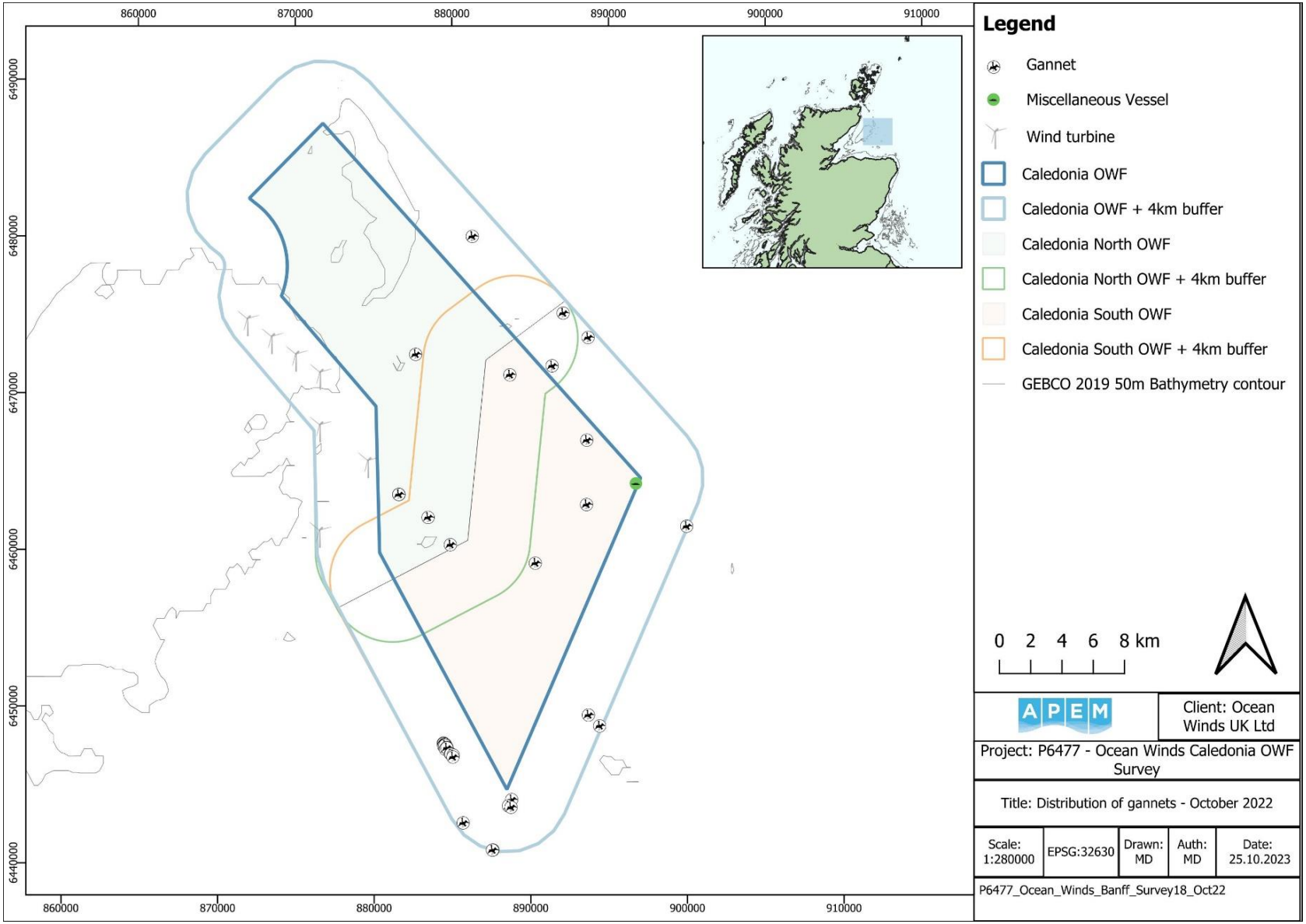



**Figure A4.323 Distribution of gannets recorded in the Survey Area in October 2022**

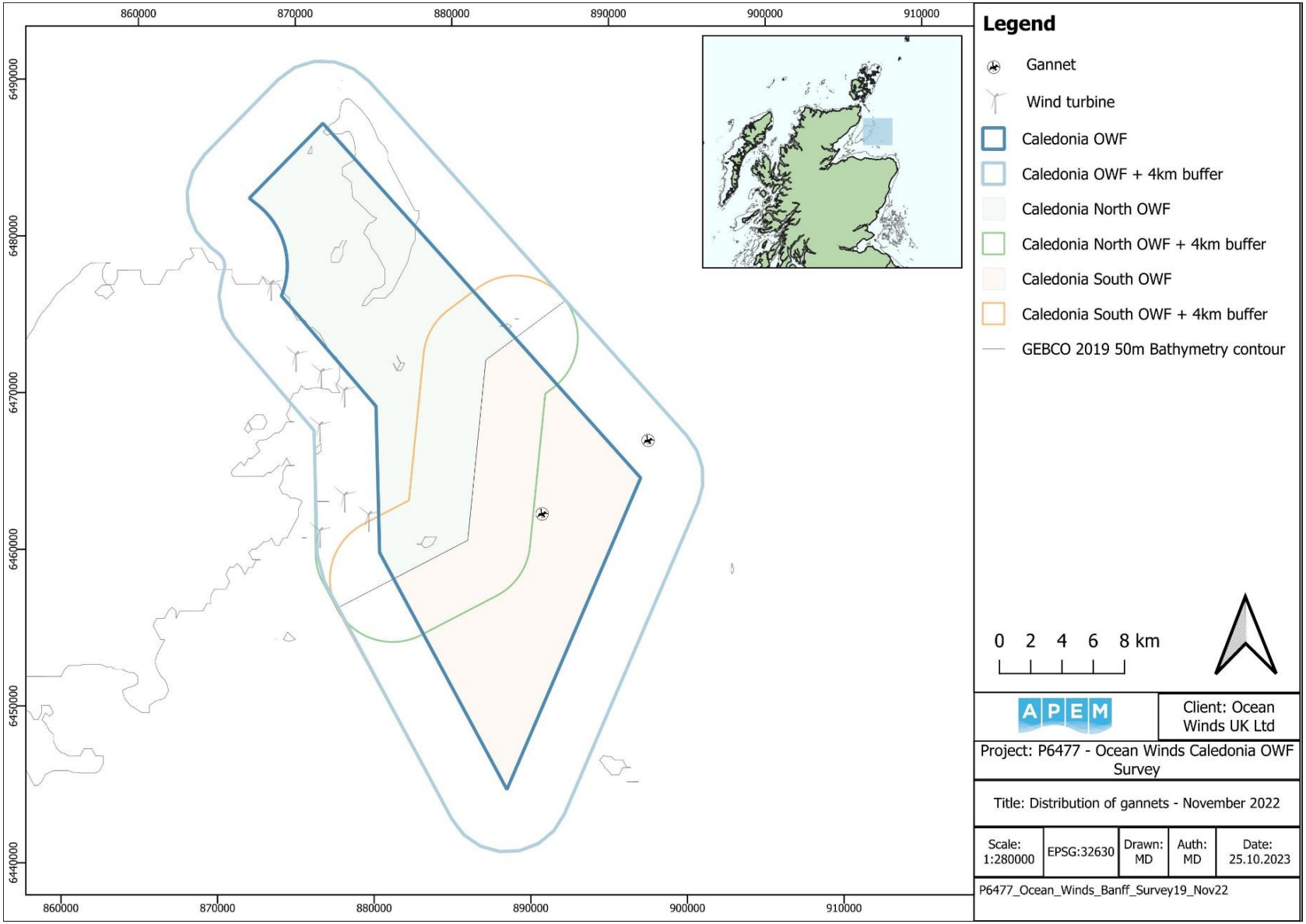



**Figure A4.324 Distribution of gannets recorded in the Survey Area in November 2022**

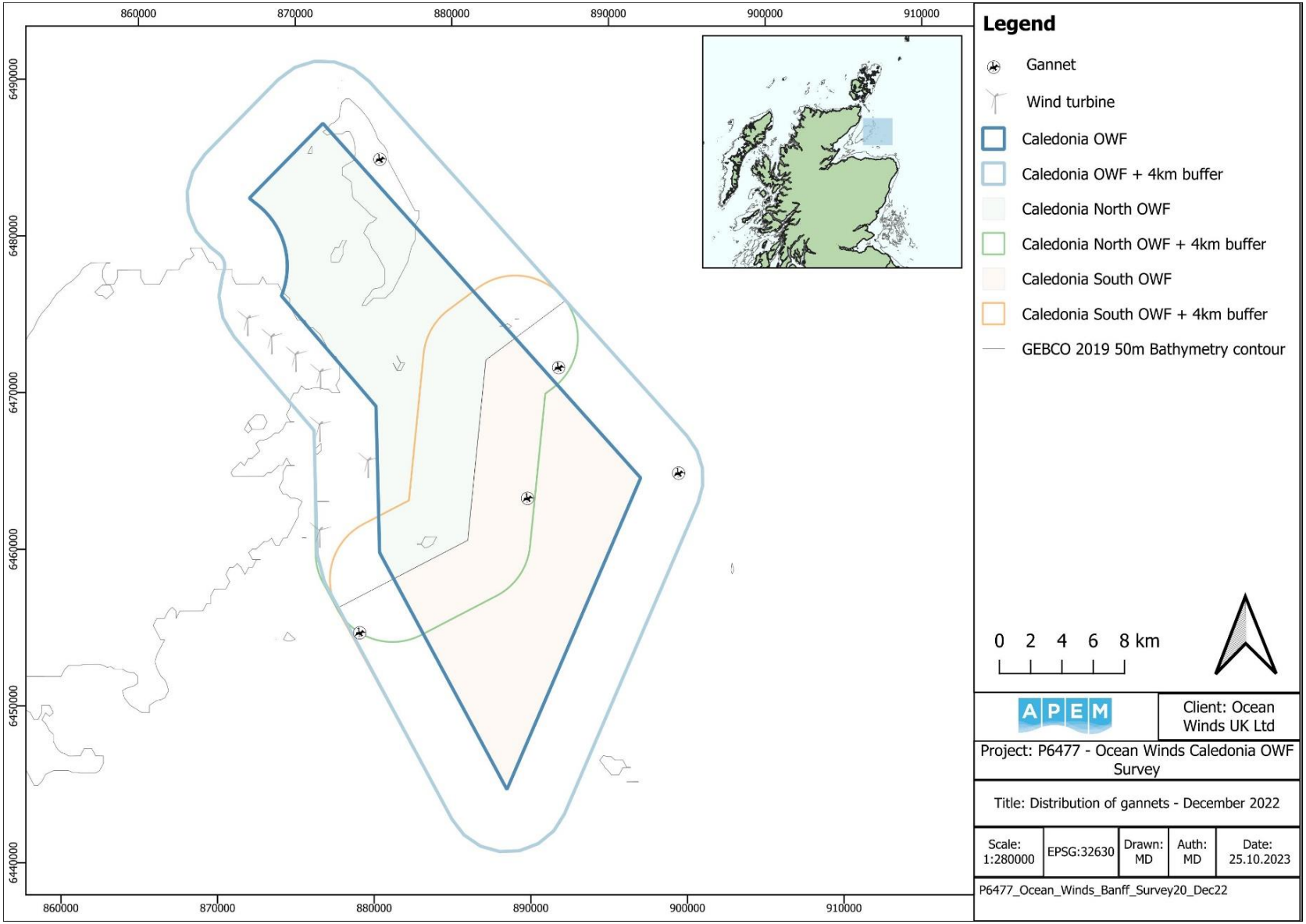



**Figure A4.325 Distribution of gannets recorded in the Survey Area in December 2022**

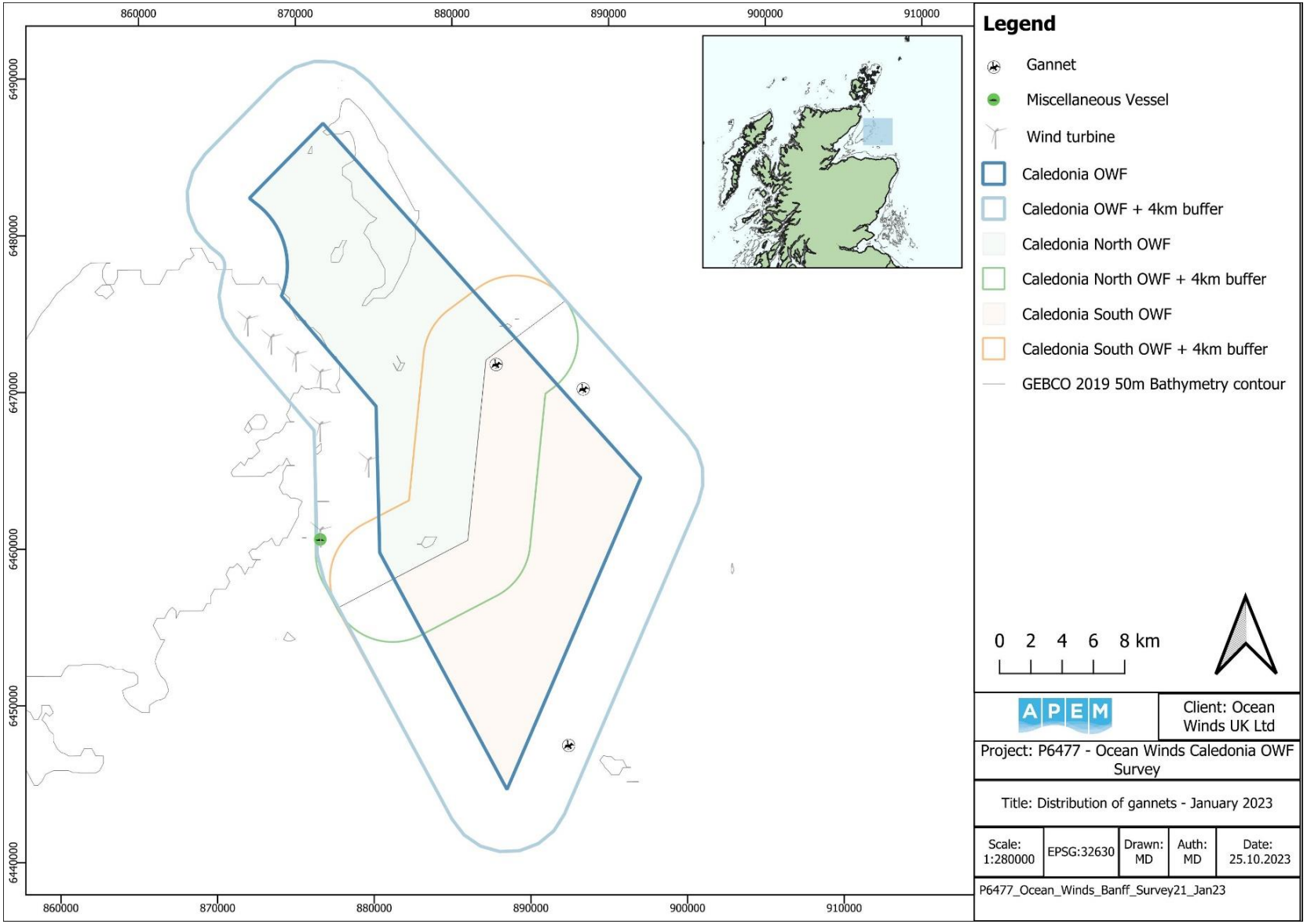



**Figure A4.326 Distribution of gannets recorded in the Survey Area in January 2023**

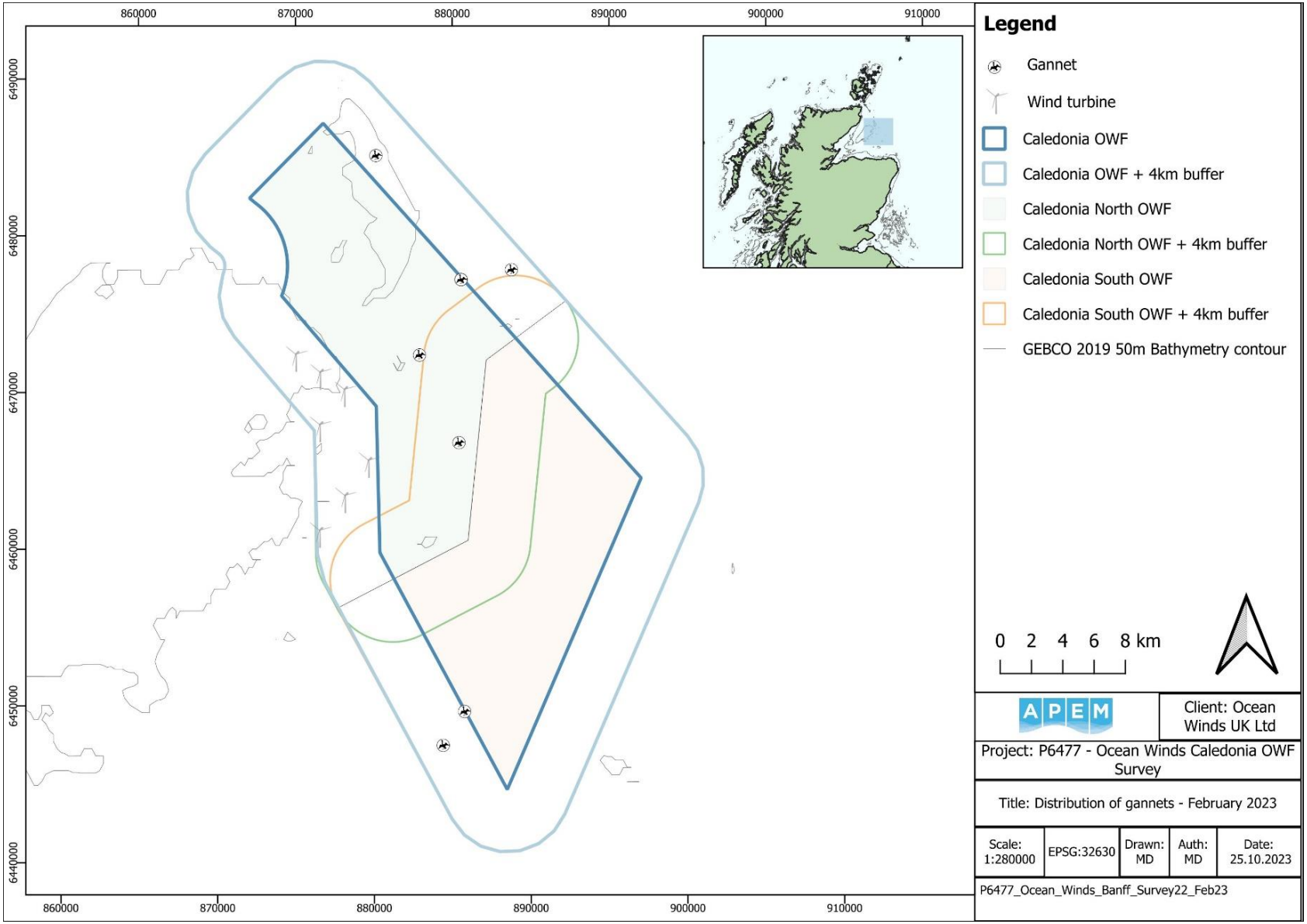



**Figure A4.327 Distribution of gannets recorded in the Survey Area in February 2023**

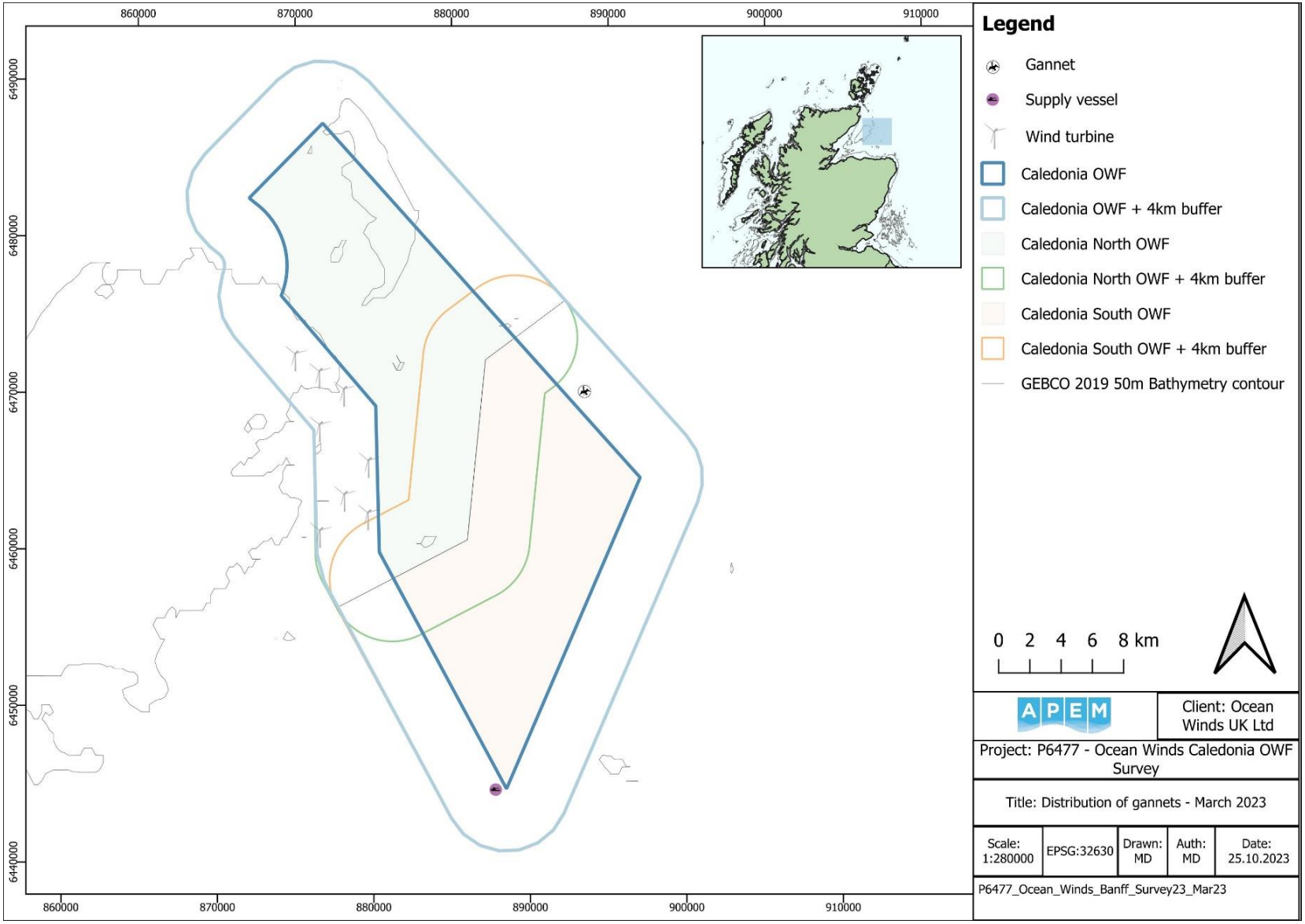



**Figure A4.328 Distribution of gannets recorded in the Survey Area in March 2023**

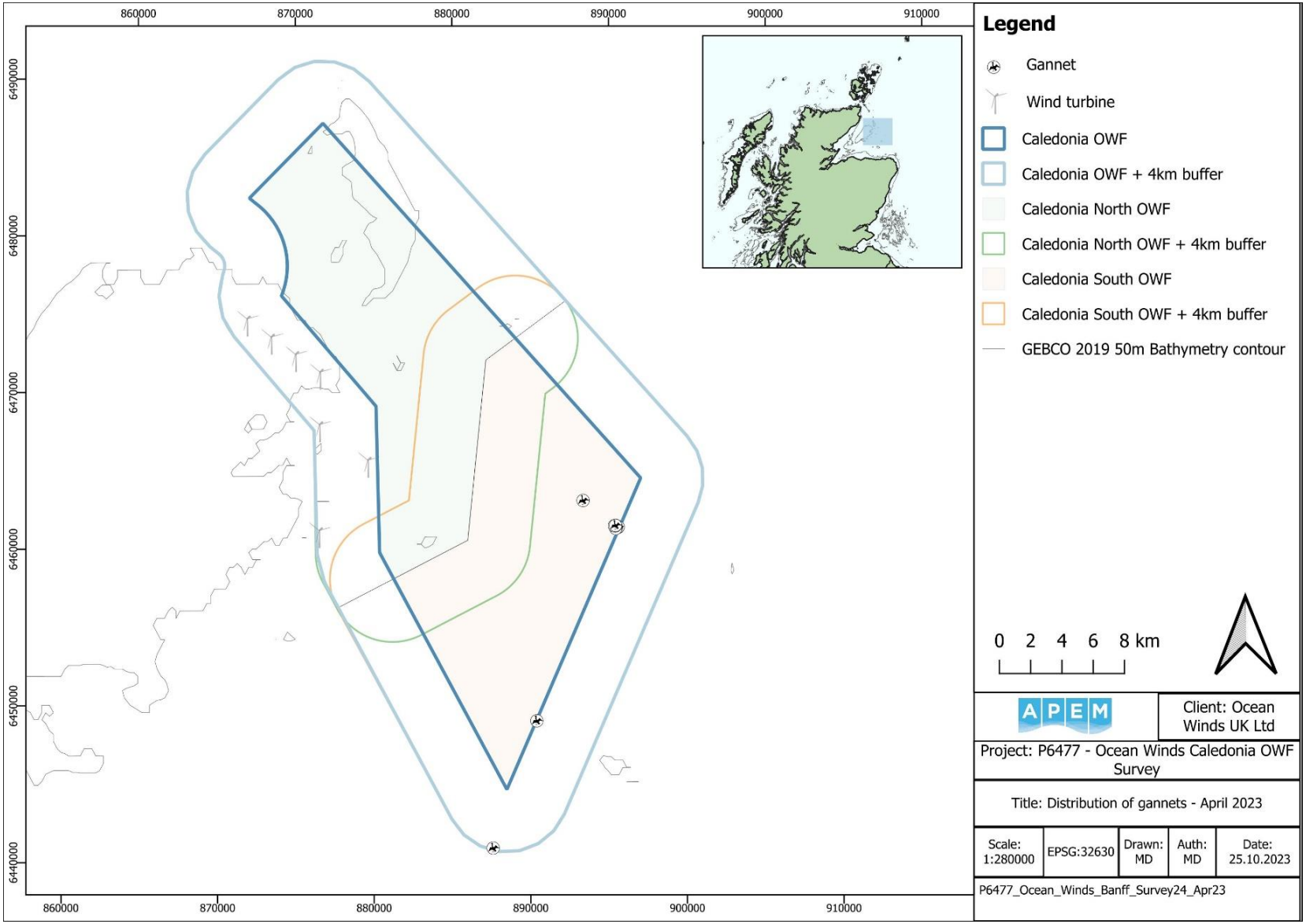



**Figure A4.329 Distribution of gannets recorded in the Survey Area in April 2023**

## Unidentified thrush species

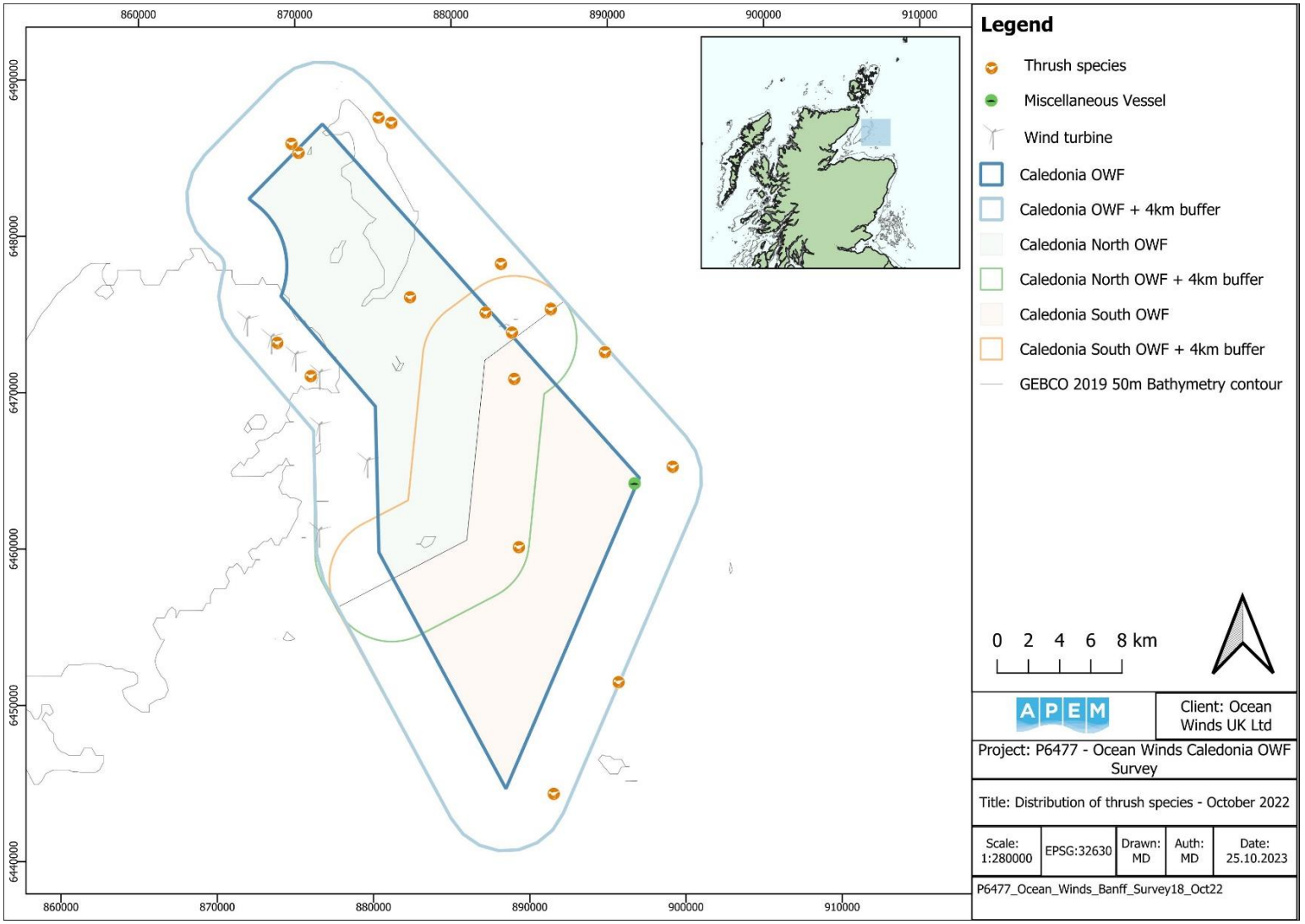



**Figure A4.330 Distribution of thrush species recorded in the Survey Area in October 2022**

## Unidentified passerine species

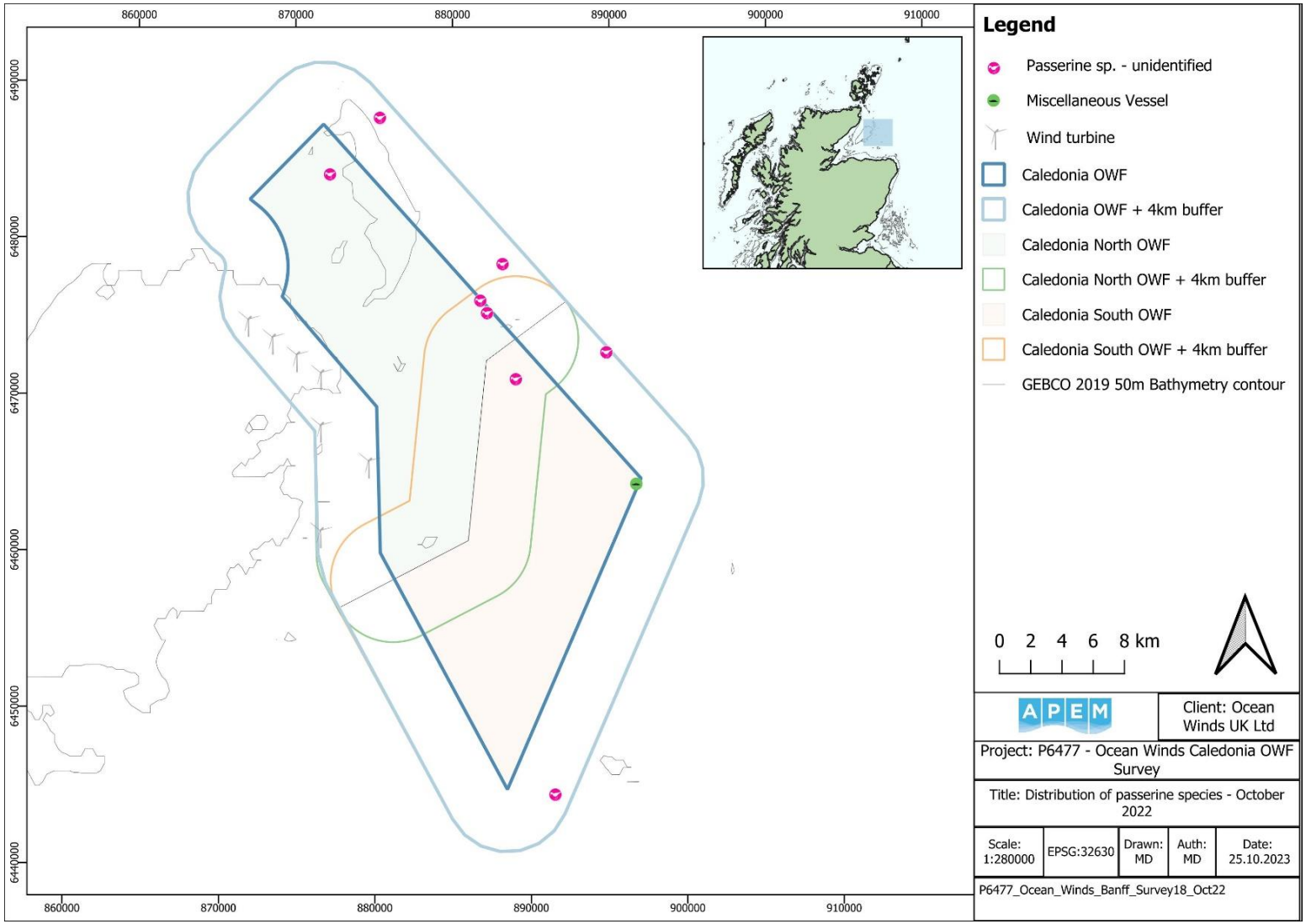



**Figure A4.331 Distribution of passerine species recorded in the Survey Area in October 2022**

## Unidentified bird species

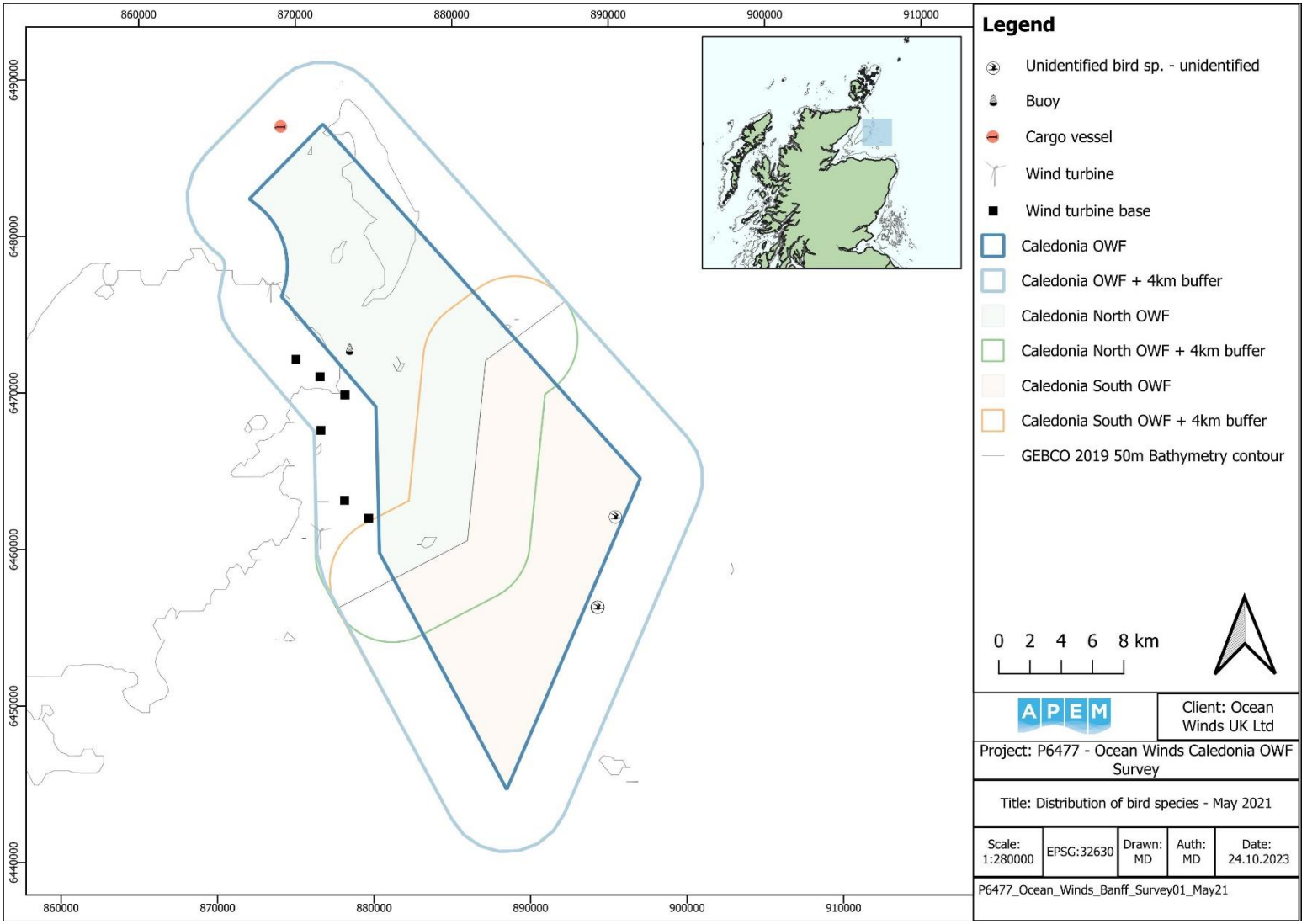



**Figure A4.332 Distribution of unidentified bird species recorded in the Survey Area in May 2021**

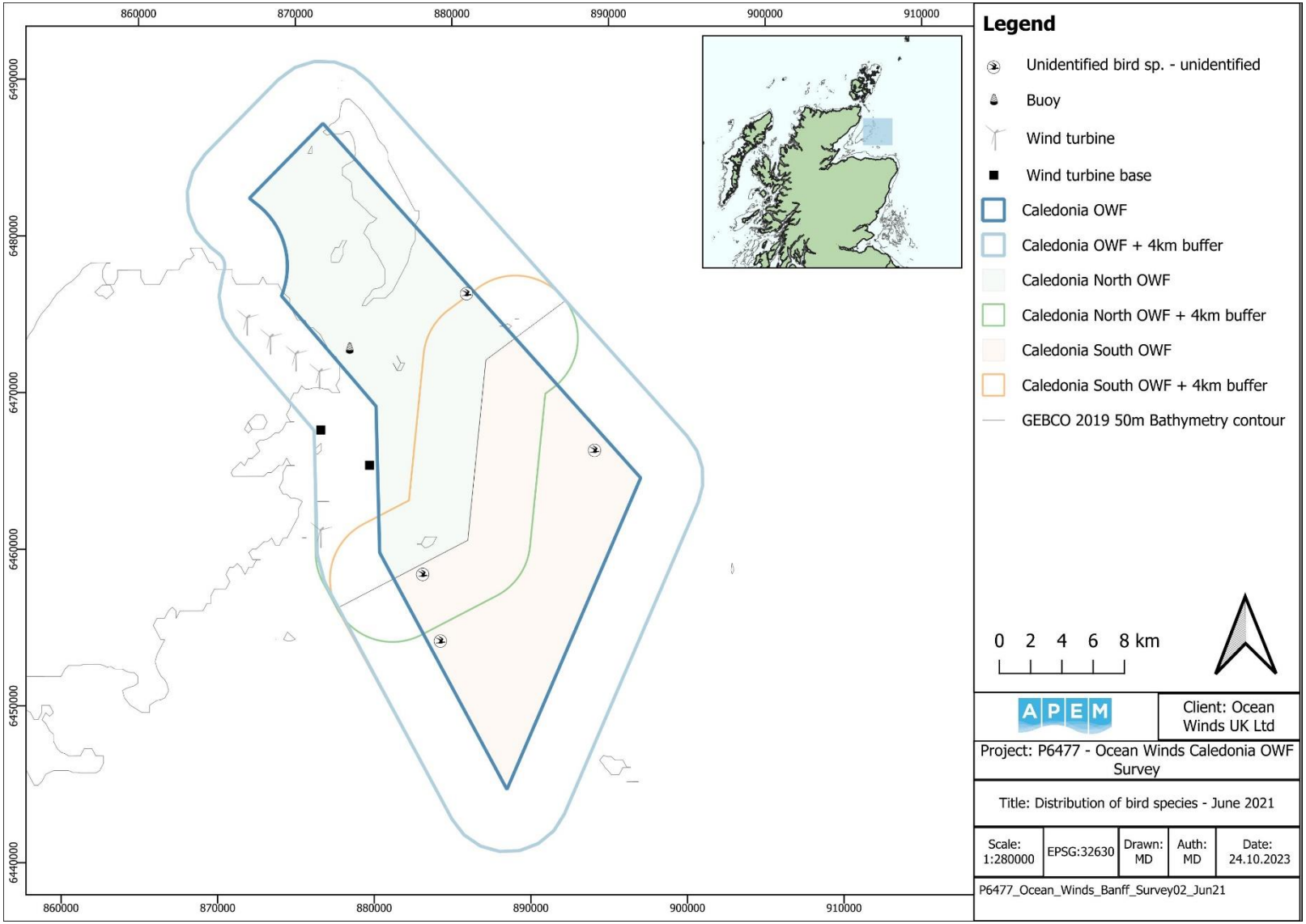



**Figure A4.333 Distribution of unidentified bird species recorded in the Survey Area in June 2021**

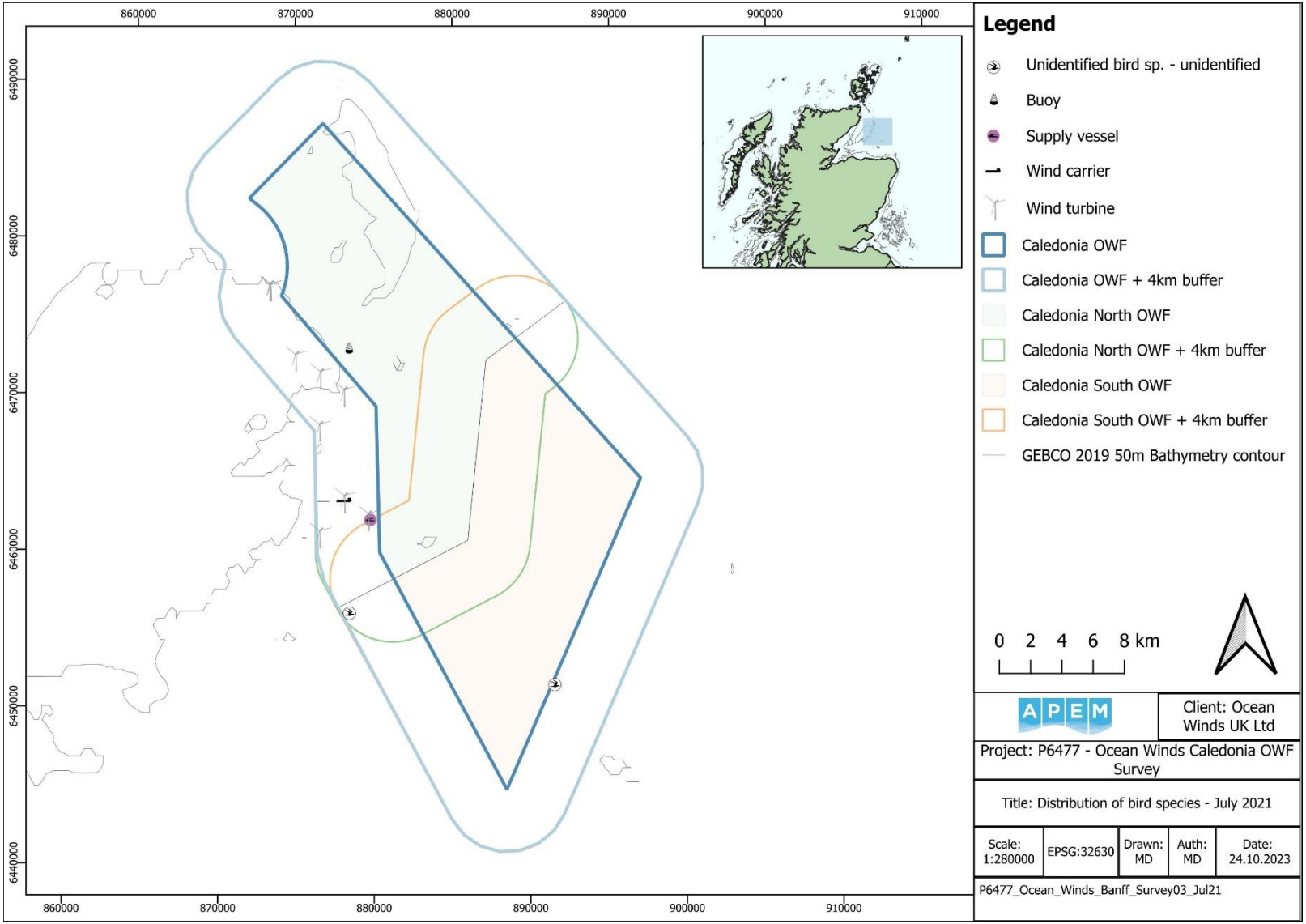



**Figure A4.334 Distribution of unidentified bird species recorded in the Survey Area in July 2021**

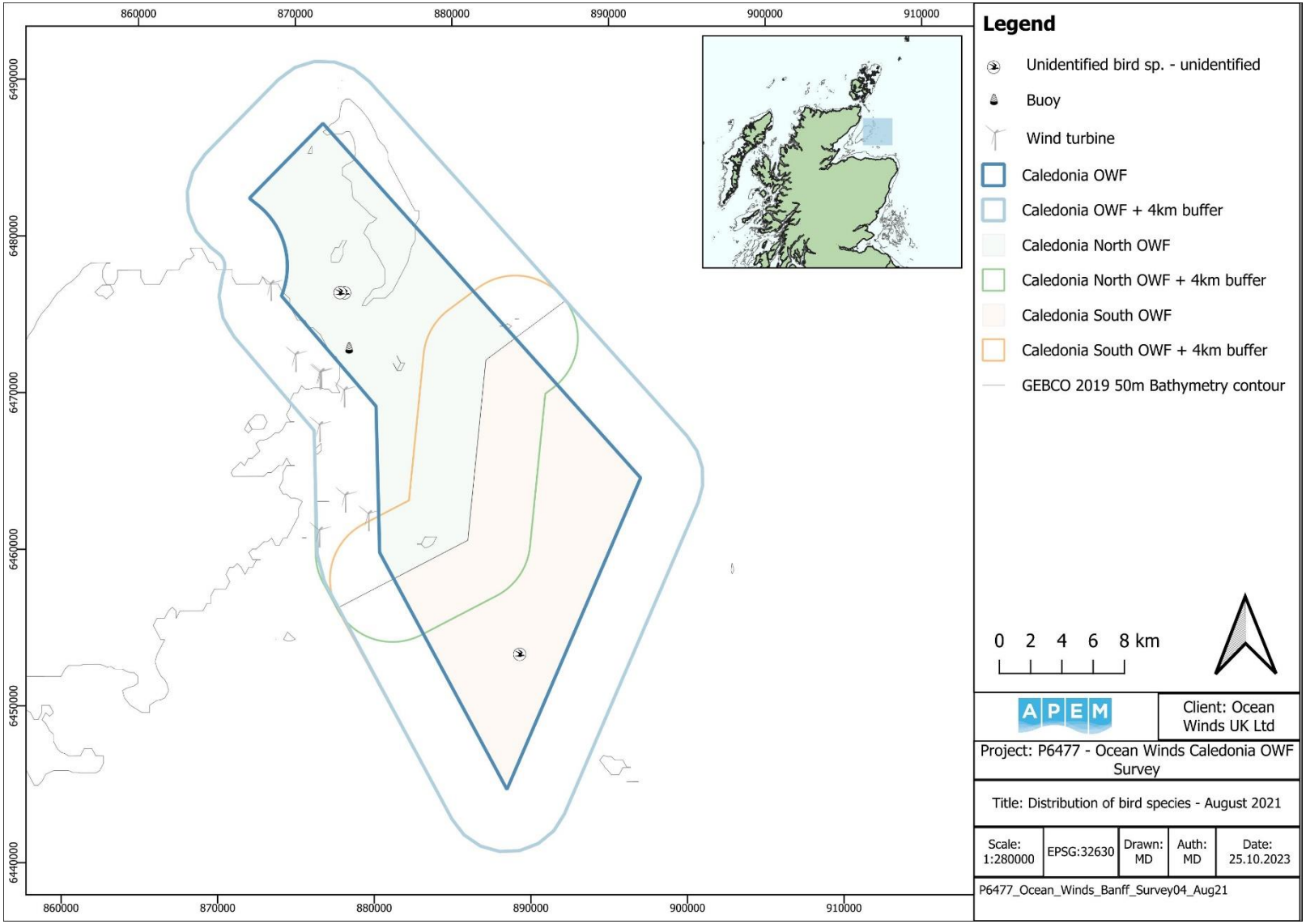



**Figure A4.335 Distribution of unidentified bird species recorded in the Survey Area in August 2021**

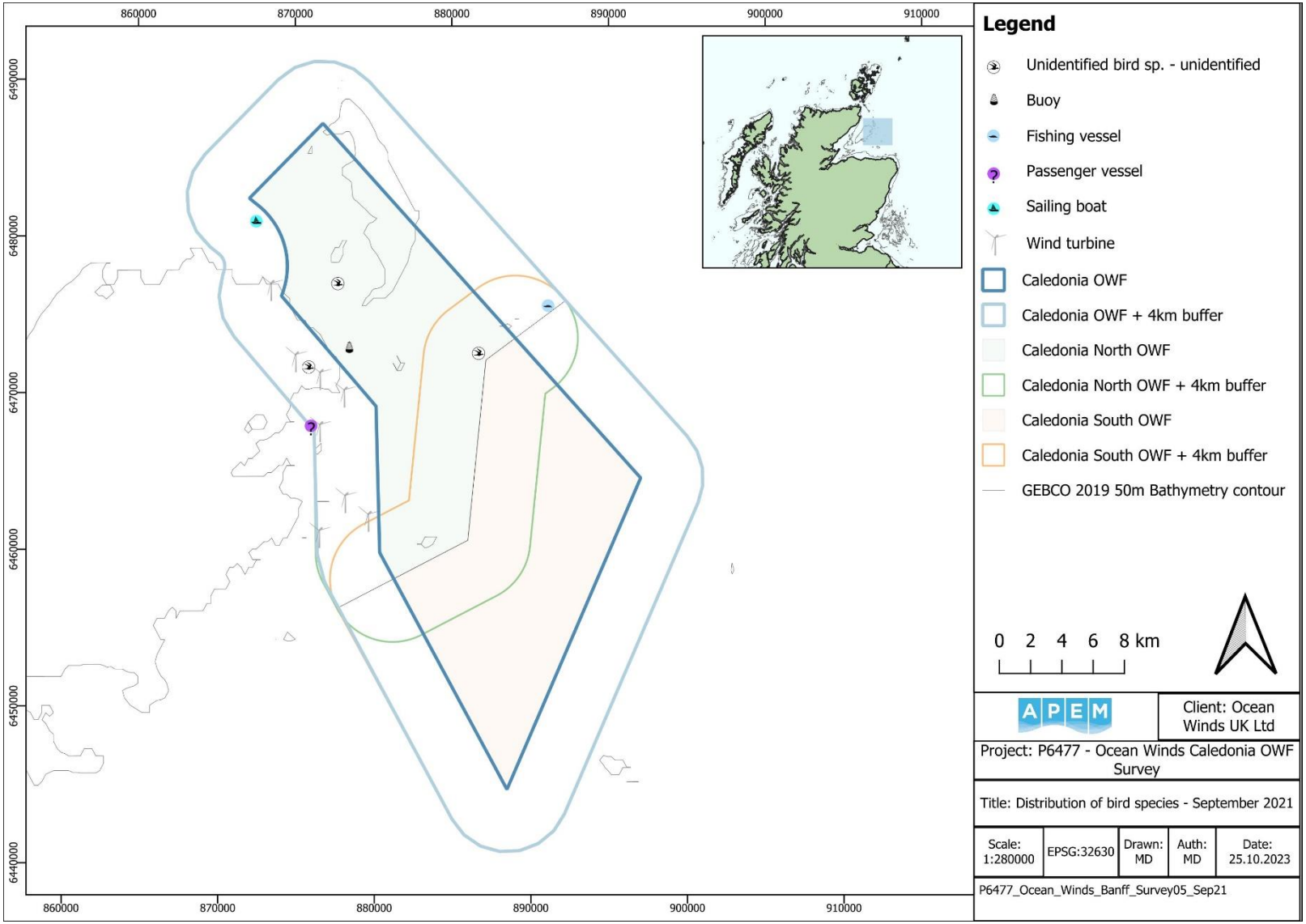



**Figure A4.336 Distribution of unidentified bird species recorded in the Survey Area in September 2021**

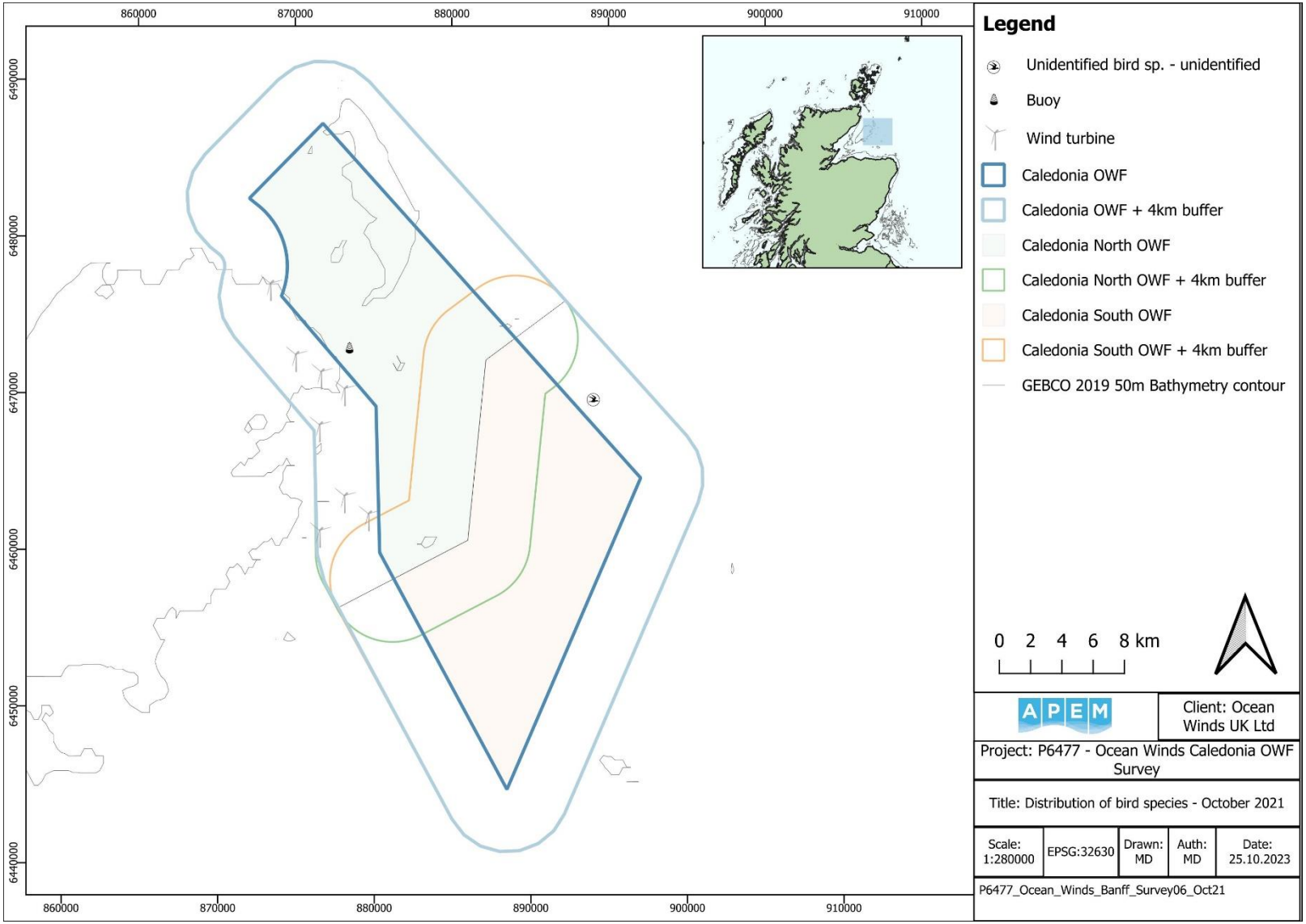



**Figure A4.337 Distribution of unidentified bird species recorded in the Survey Area in October 2021**

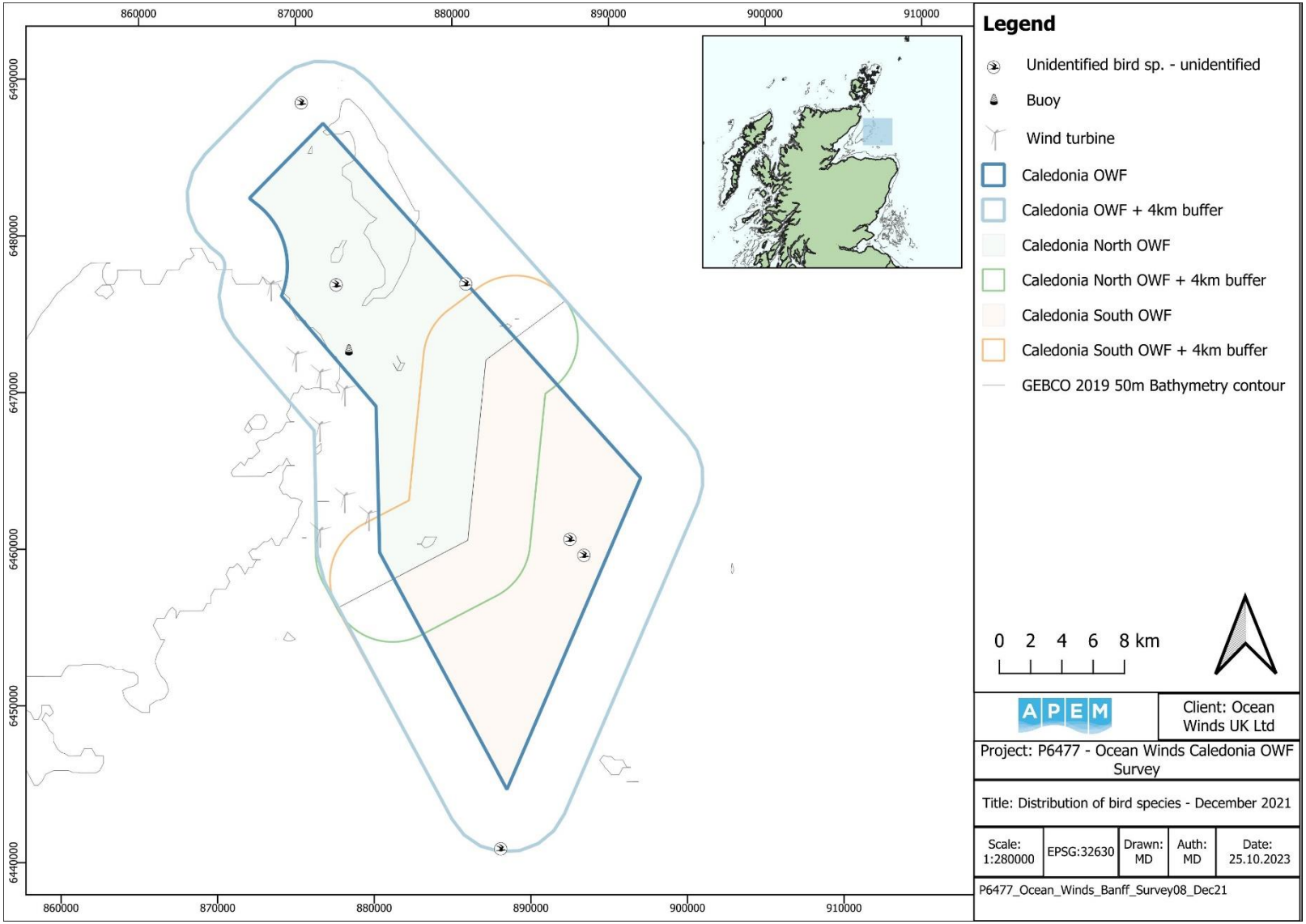



**Figure A4.338 Distribution of unidentified bird species recorded in the Survey Area in December 2021**

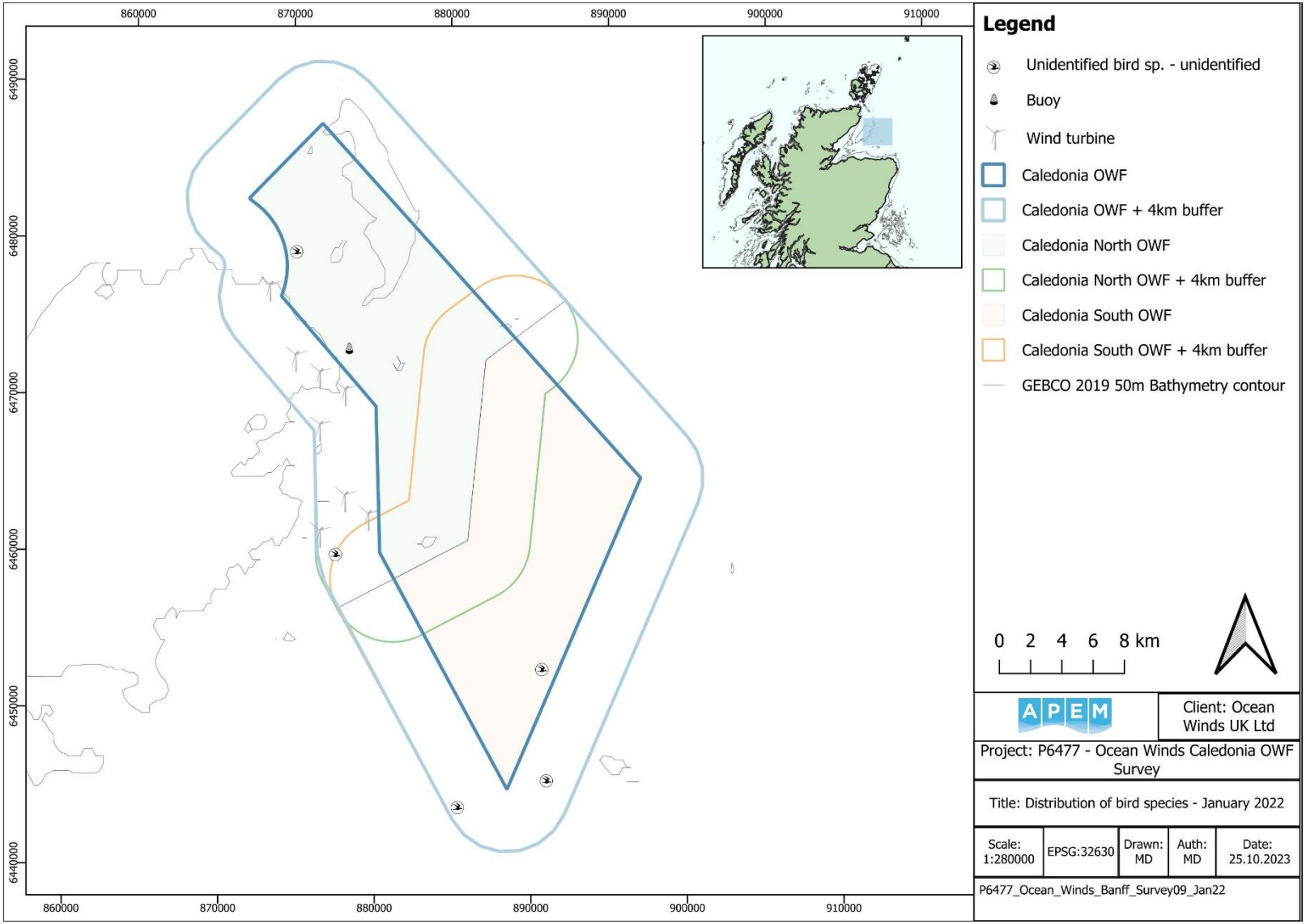



**Figure A4.339 Distribution of unidentified bird species recorded in the Survey Area in January 2022**

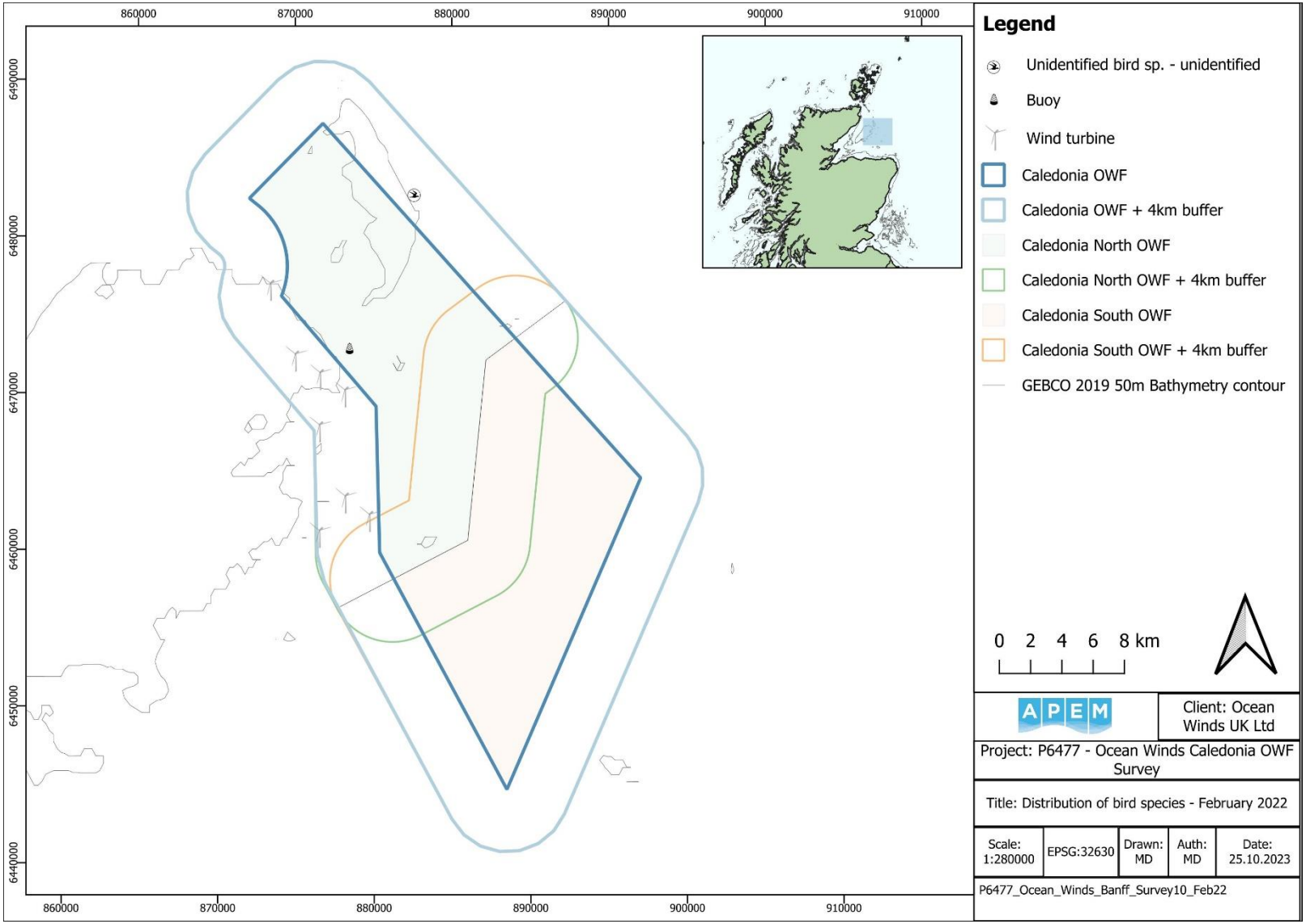



**Figure A4.340 Distribution of unidentified bird species recorded in the Survey Area in February 2022**

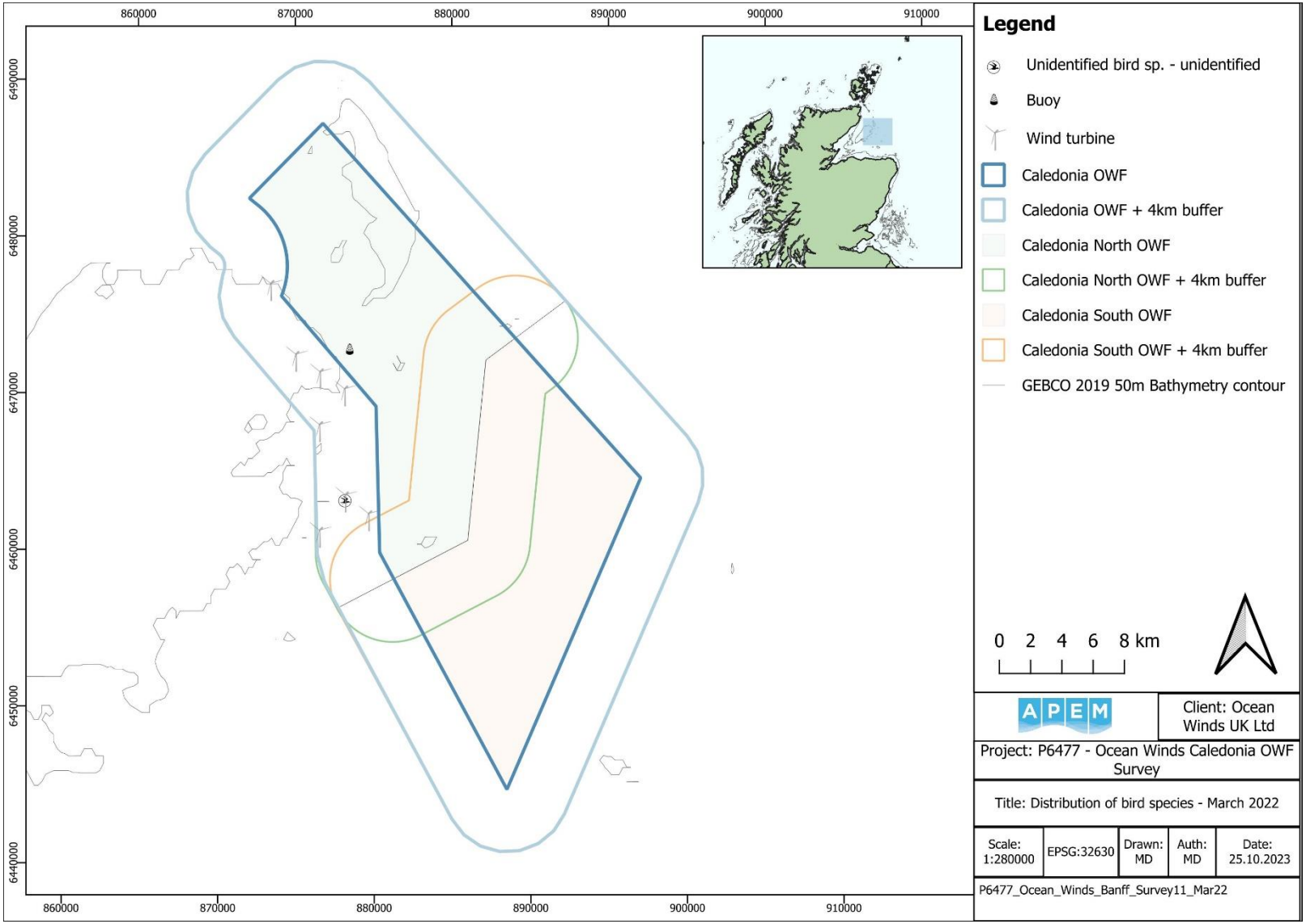



**Figure A4.341 Distribution of unidentified bird species recorded in the Survey Area in March 2022**

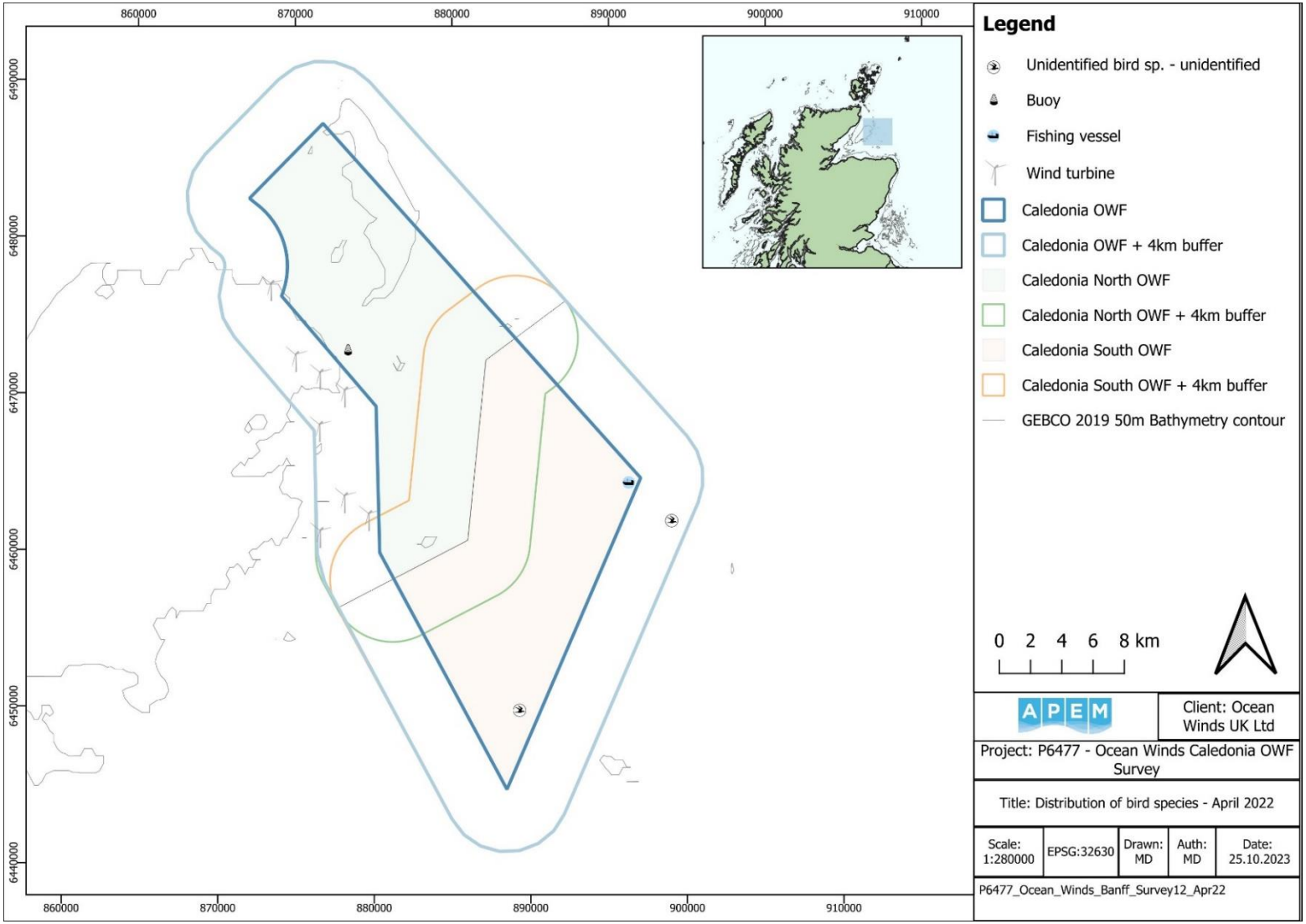



**Figure A4.342 Distribution of unidentified bird species[1] recorded in the Survey Area in April 2022**

[1]deceased individuals

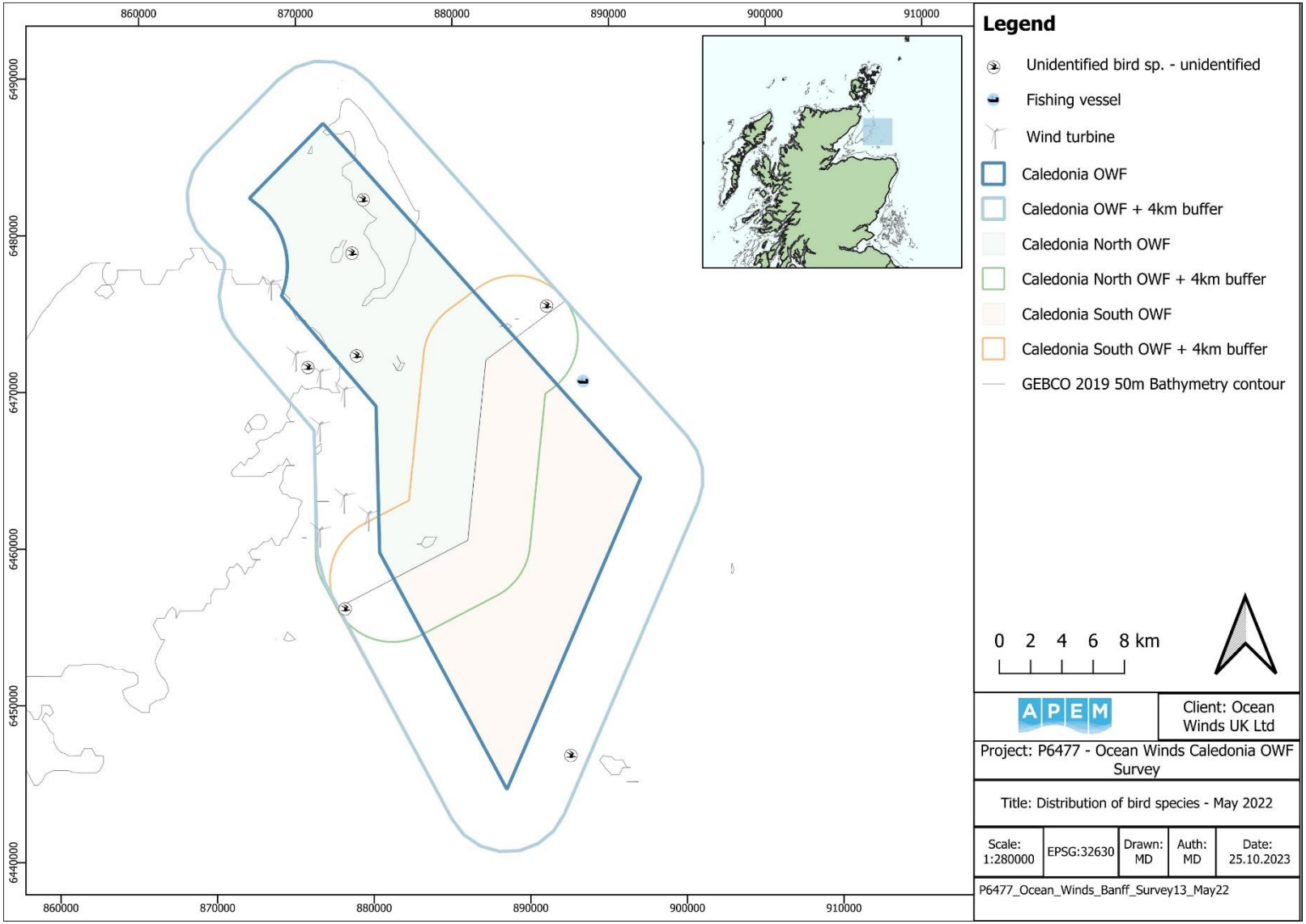



**Figure A4.343 Distribution of unidentified bird species recorded in the Survey Area in May 2022**

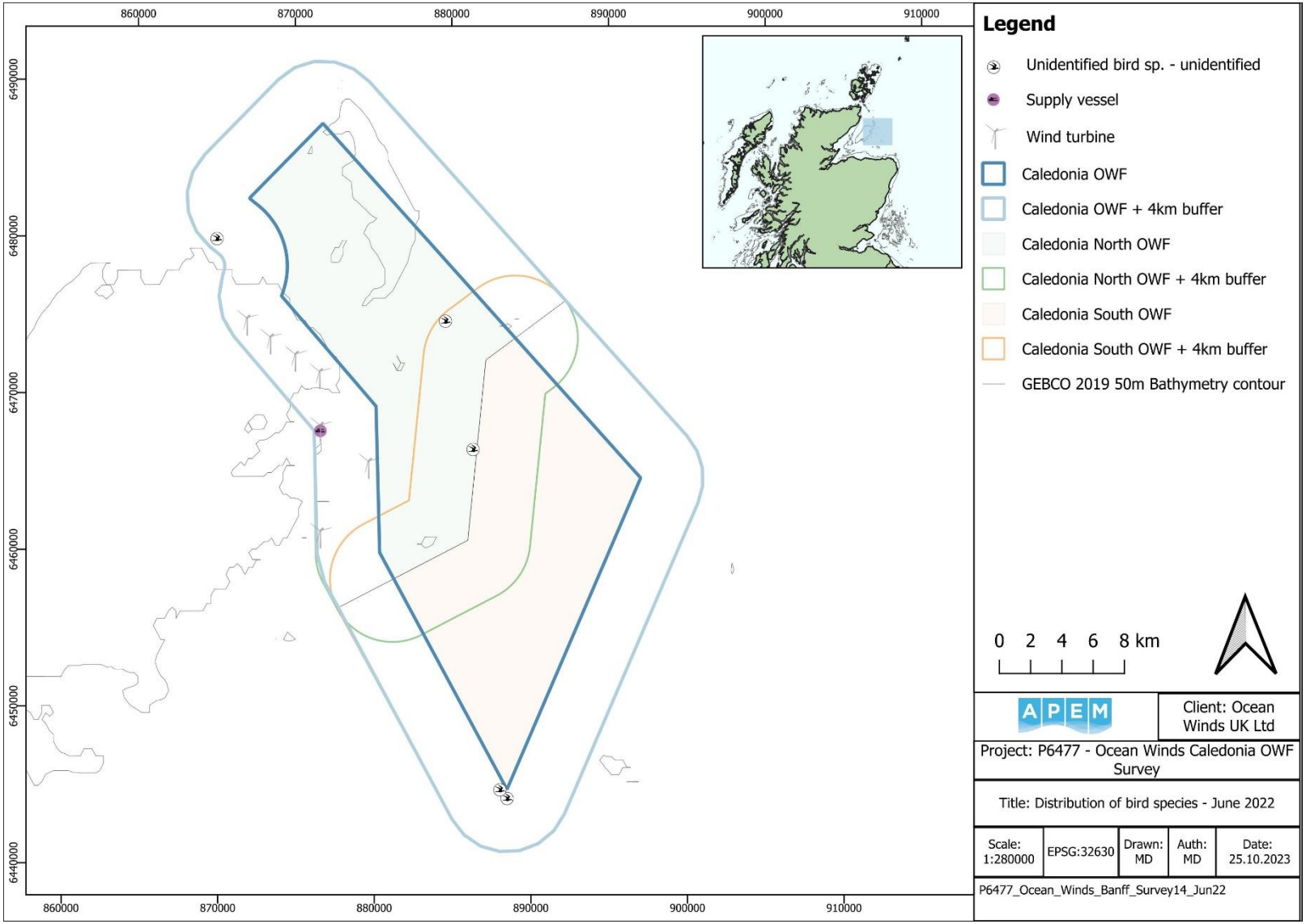



**Figure A4.344 Distribution of unidentified bird species recorded in the Survey Area in June 2022**

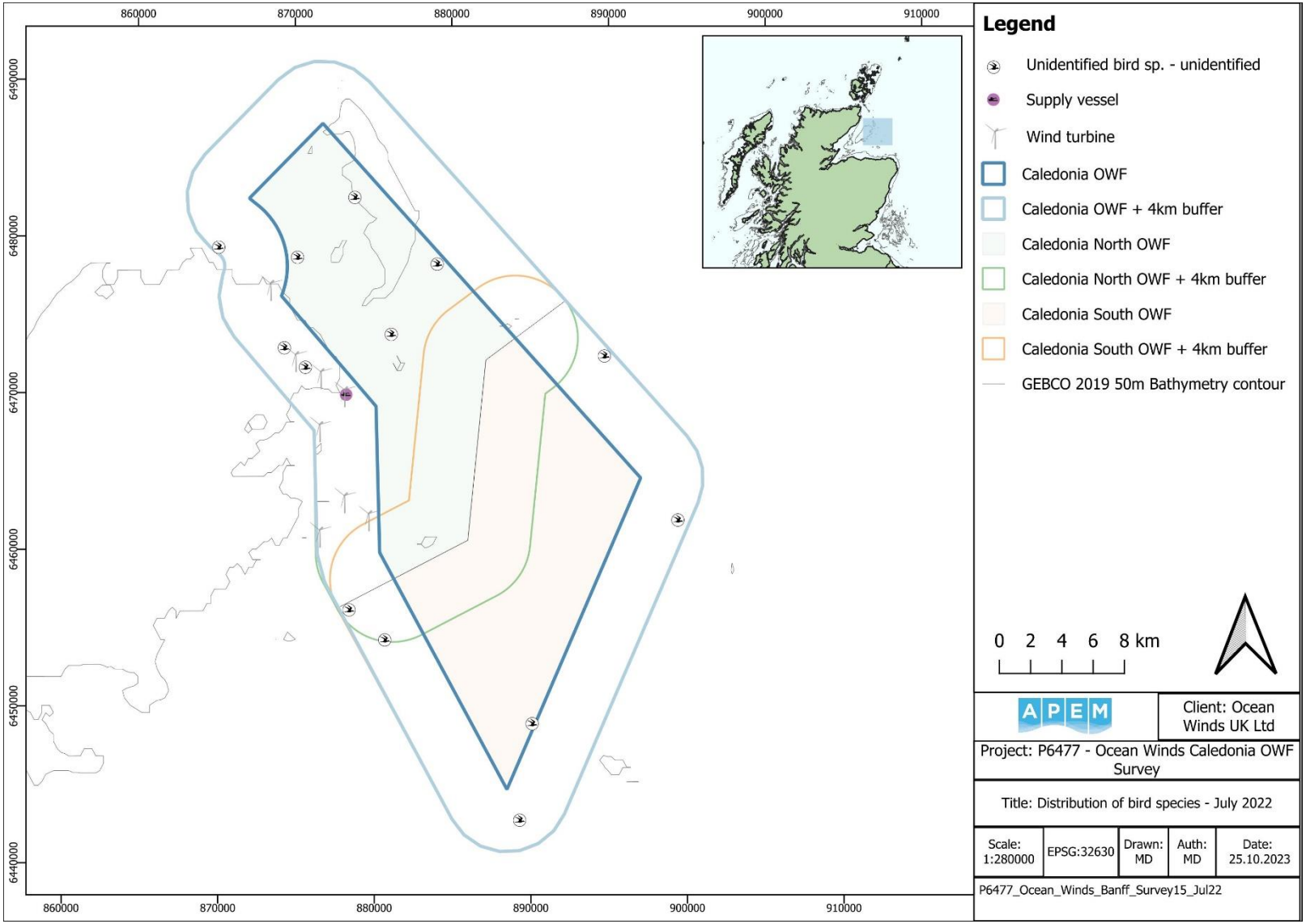



**Figure A4.345 Distribution of unidentified bird species recorded in the Survey Area in July 2022**

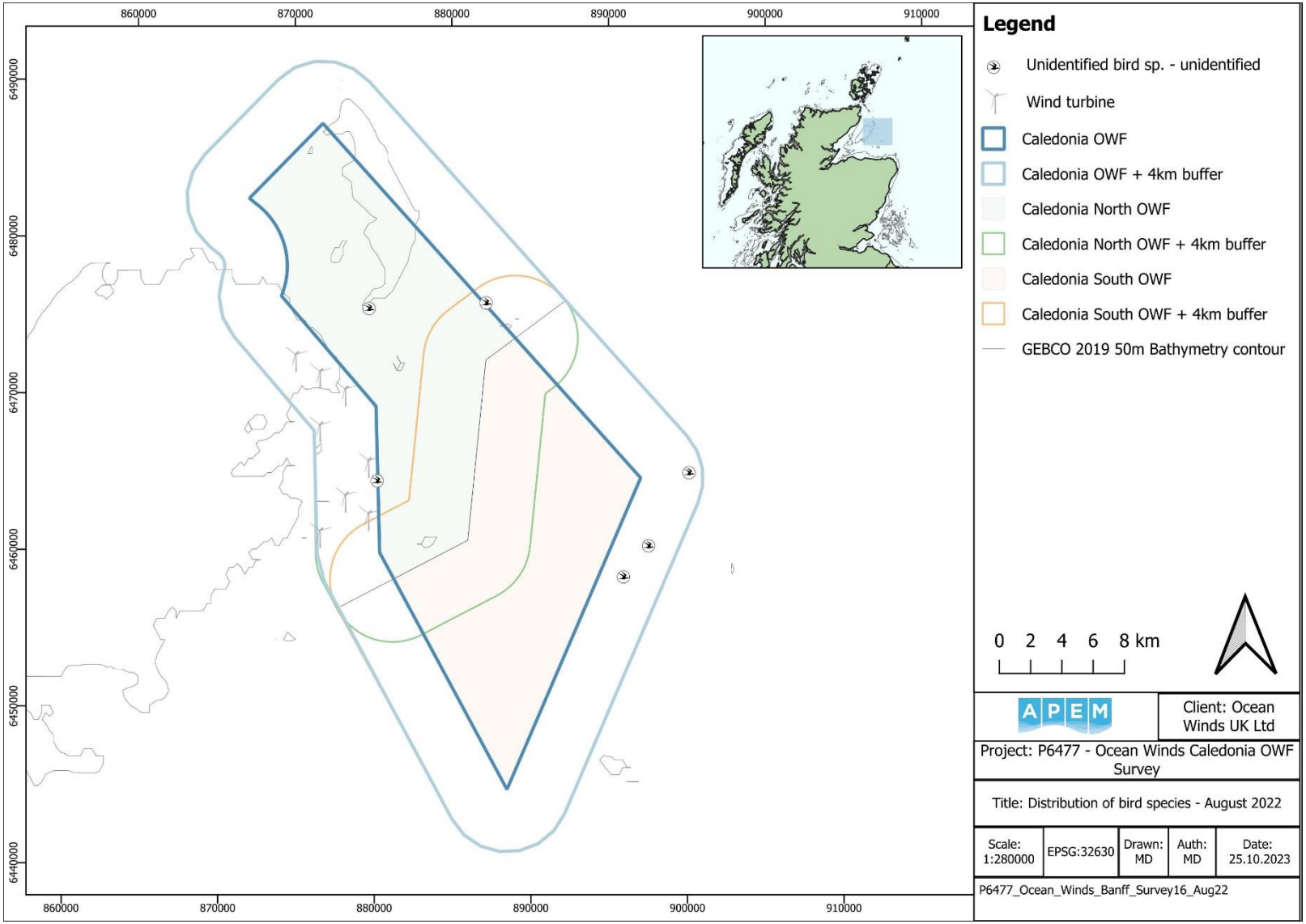



**Figure A4.346 Distribution of unidentified bird species recorded in the Survey Area in August 2022**

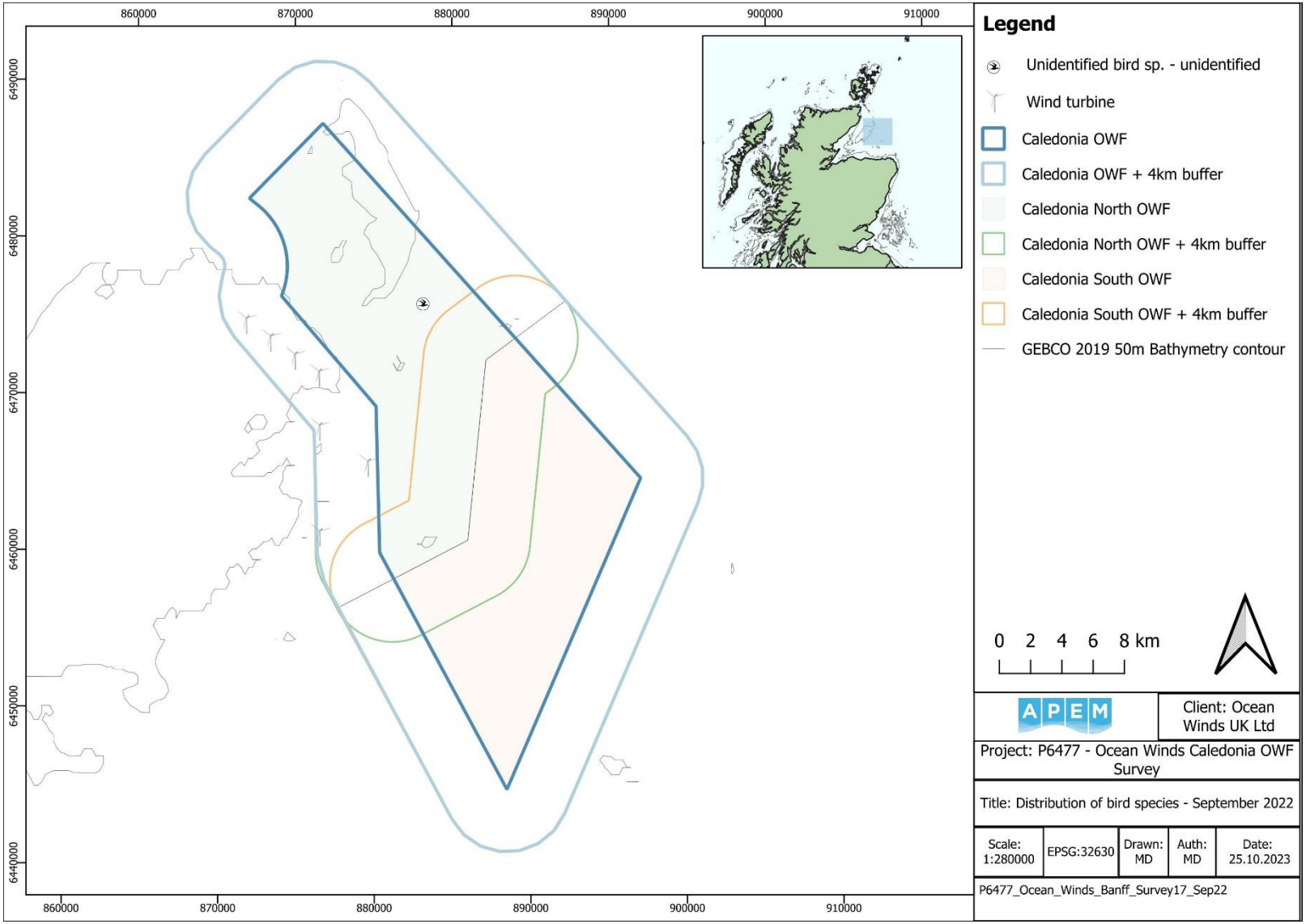



**Figure A4.347 Distribution of unidentified bird species recorded in the Survey Area in September 2022**

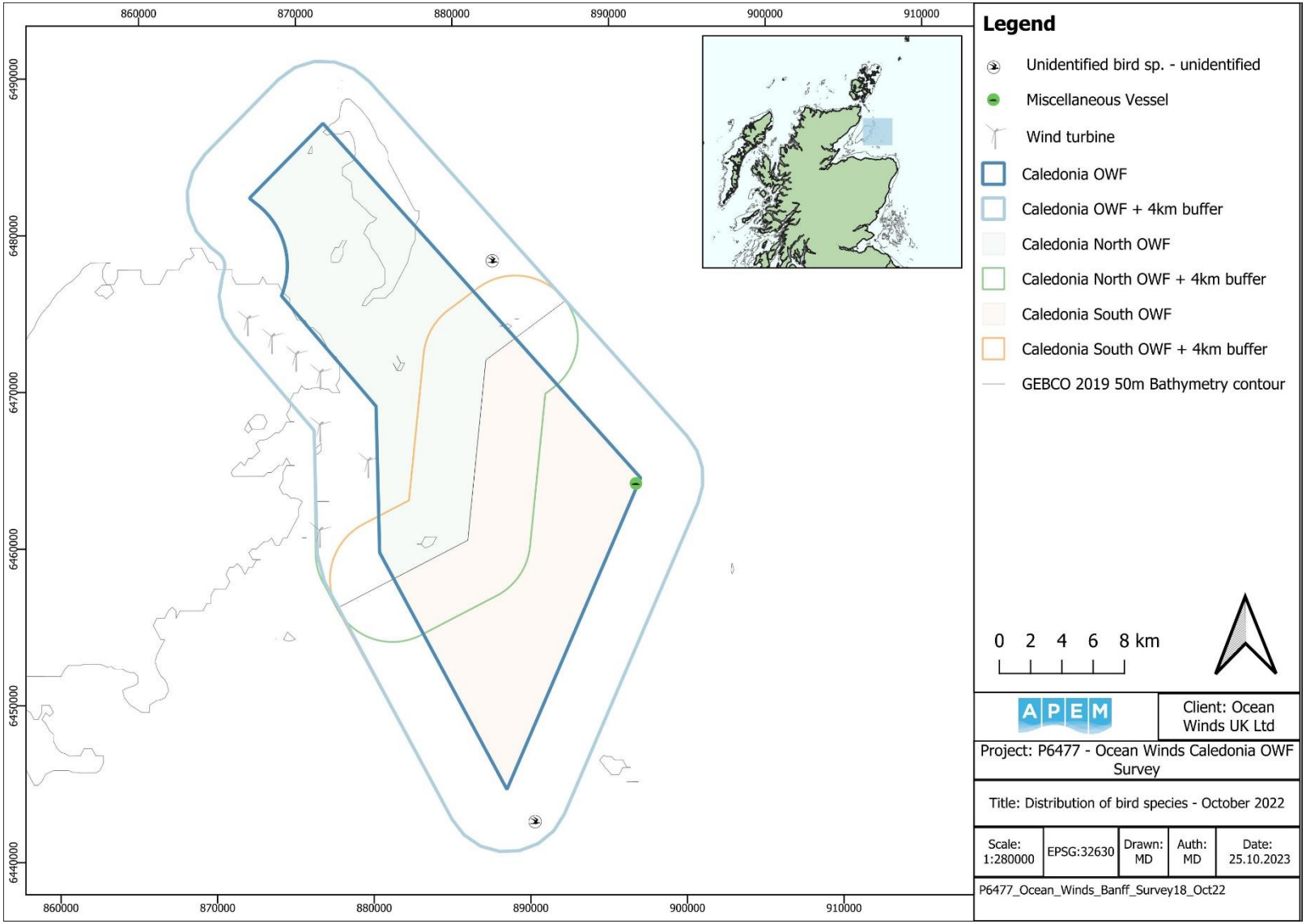



**Figure A4.348 Distribution of unidentified bird species recorded in the Survey Area in October 2022**

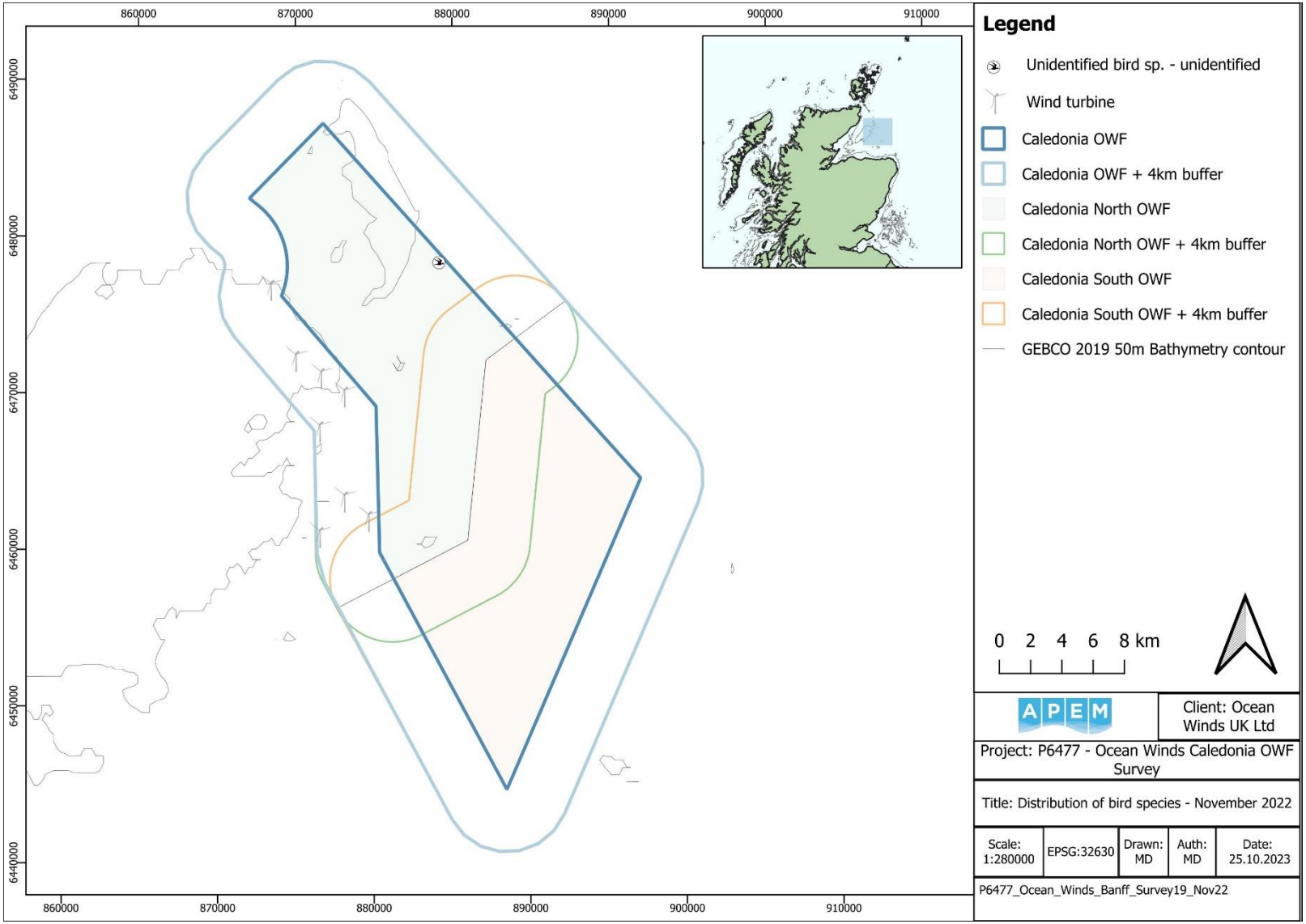



**Figure A4.349 Distribution of unidentified bird species recorded in the Survey Area in November 2022**

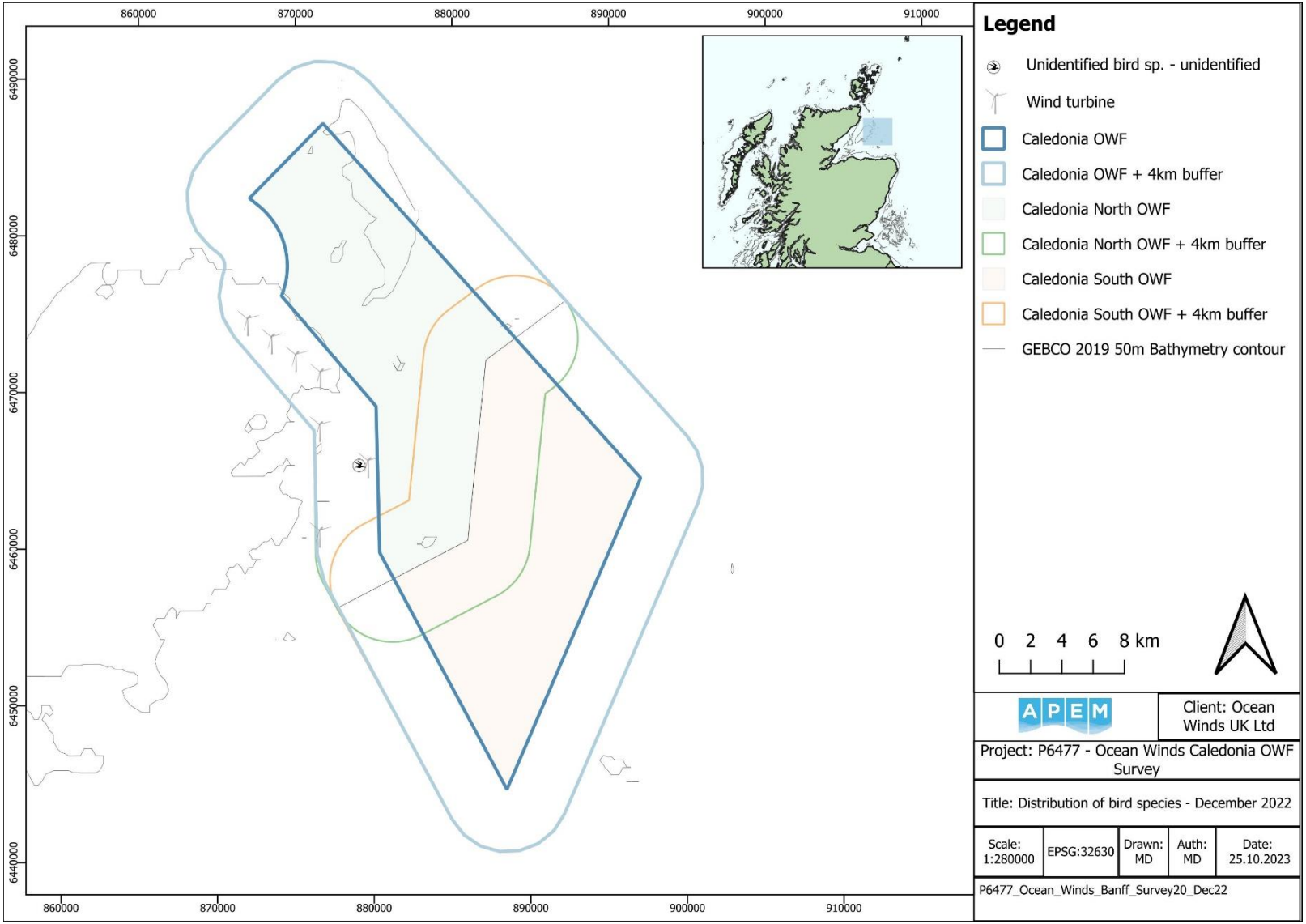



**Figure A4.350 Distribution of unidentified bird species recorded in the Survey Area in December 2022**

## Grey seal

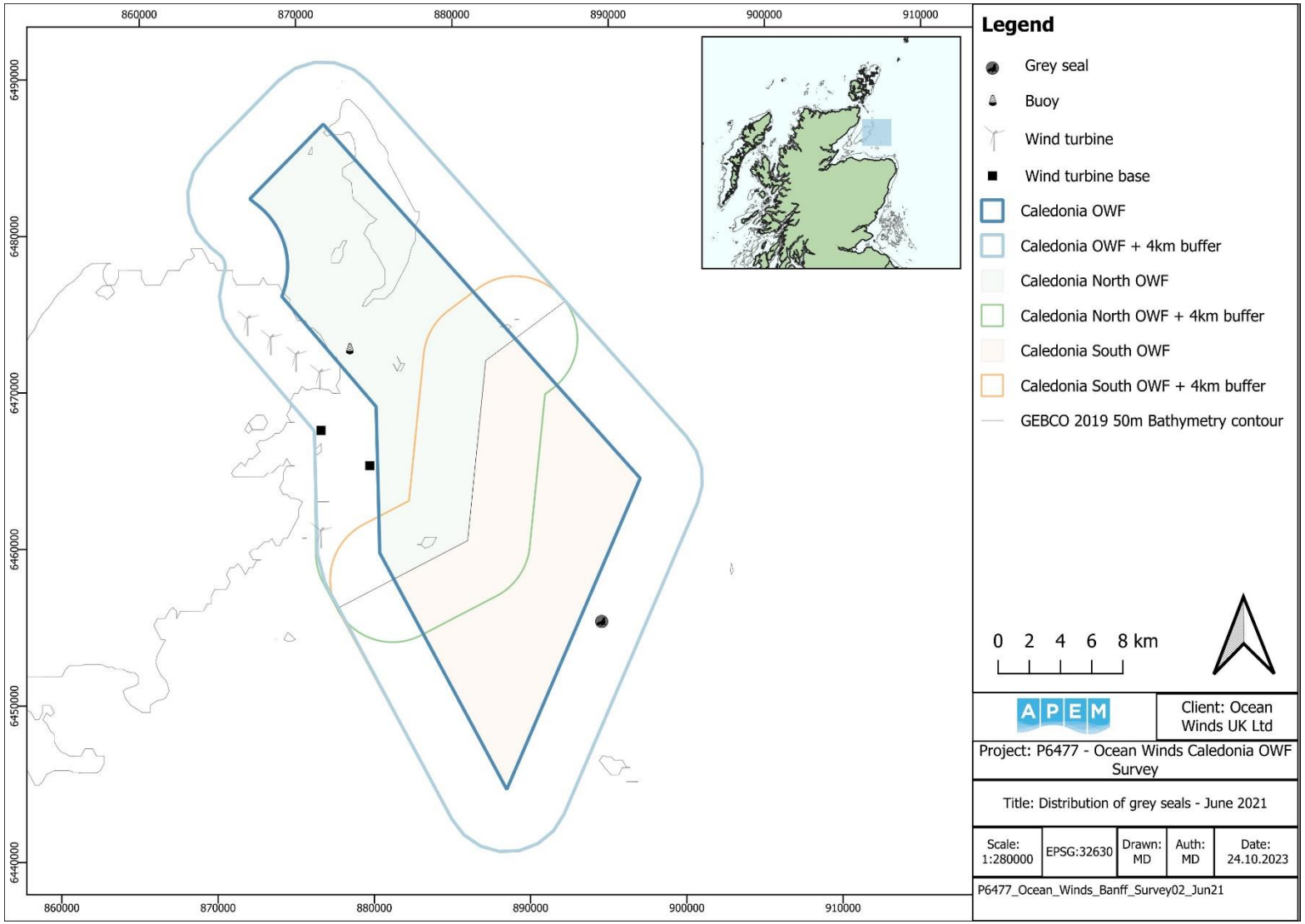



**Figure A4.351 Distribution of grey seals recorded in the Survey Area in June 2021**

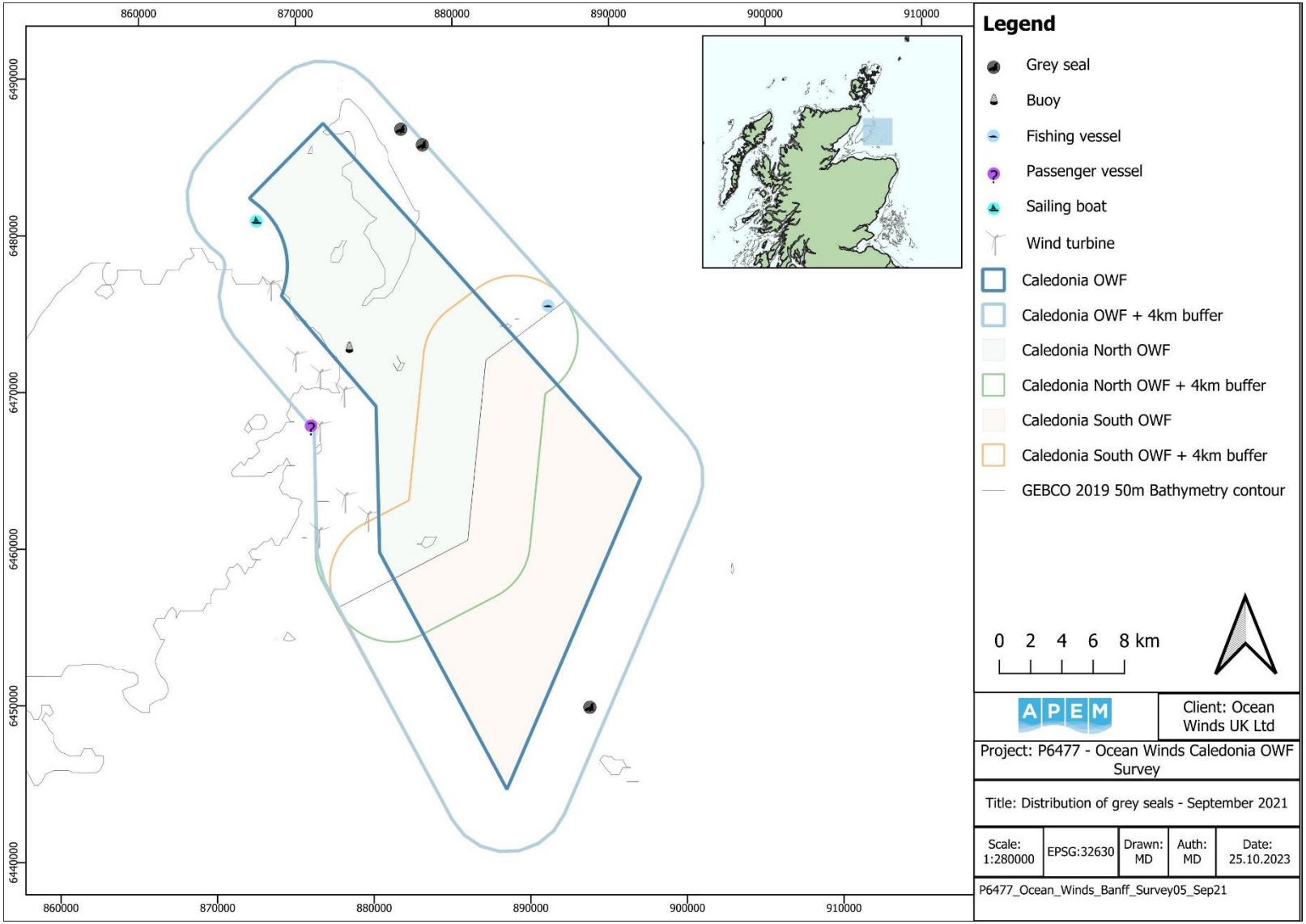



**Figure A4.352 Distribution of grey seals recorded in the Survey Area in September 2021**

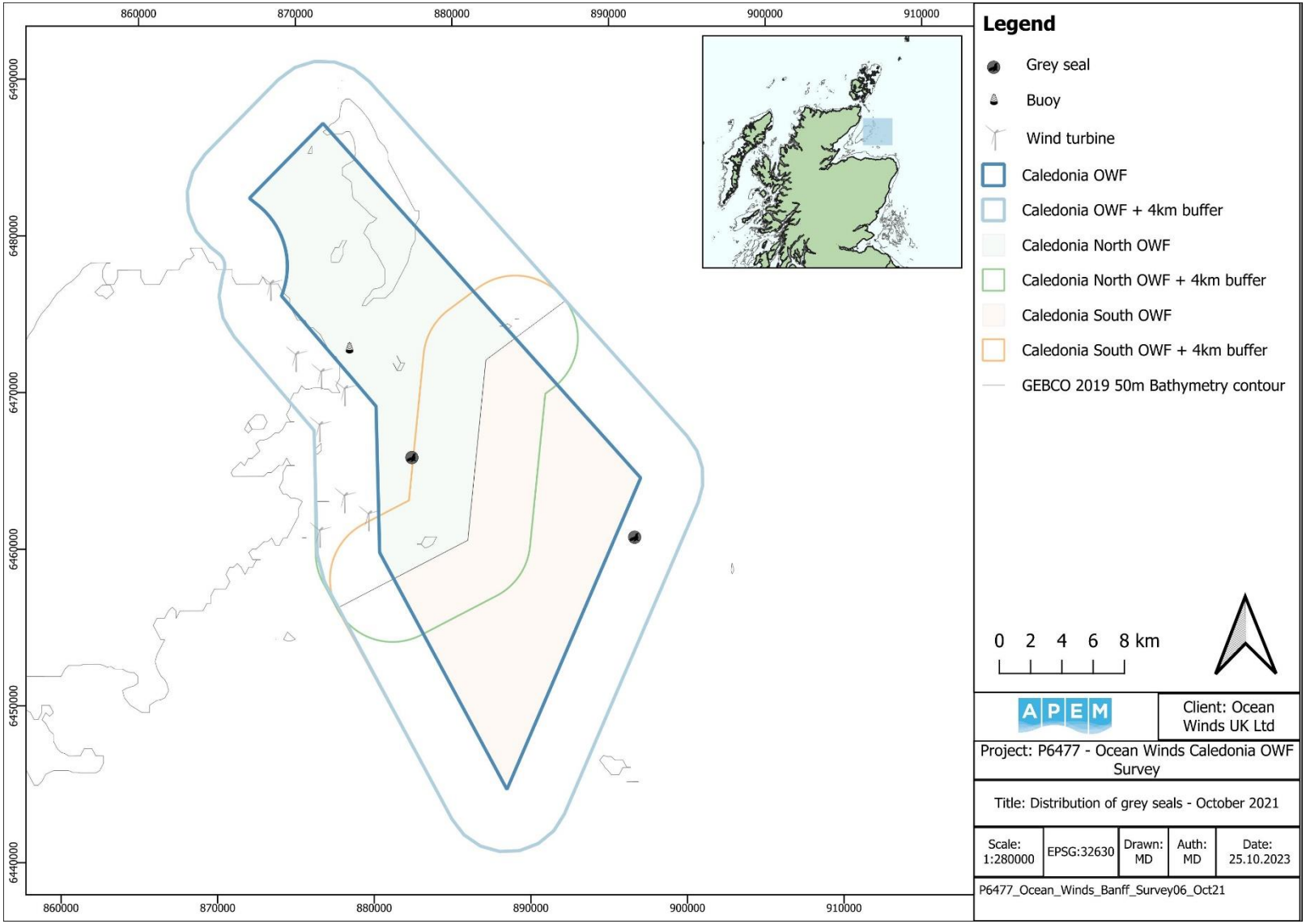



**Figure A4.353 Distribution of grey seals recorded in the Survey Area in October 2021**

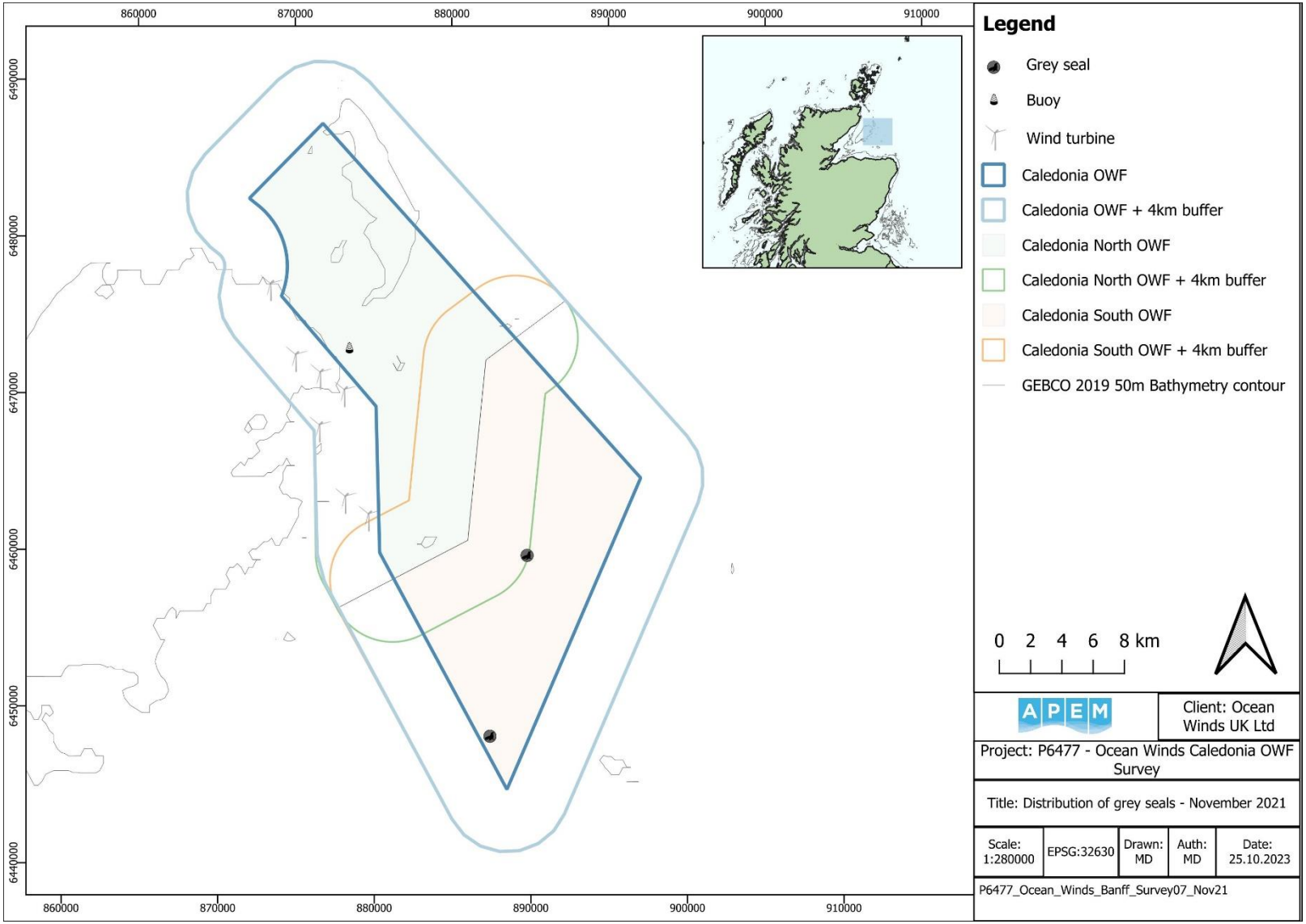



**Figure A4.354 Distribution of grey seals recorded in the Survey Area in November 2021**

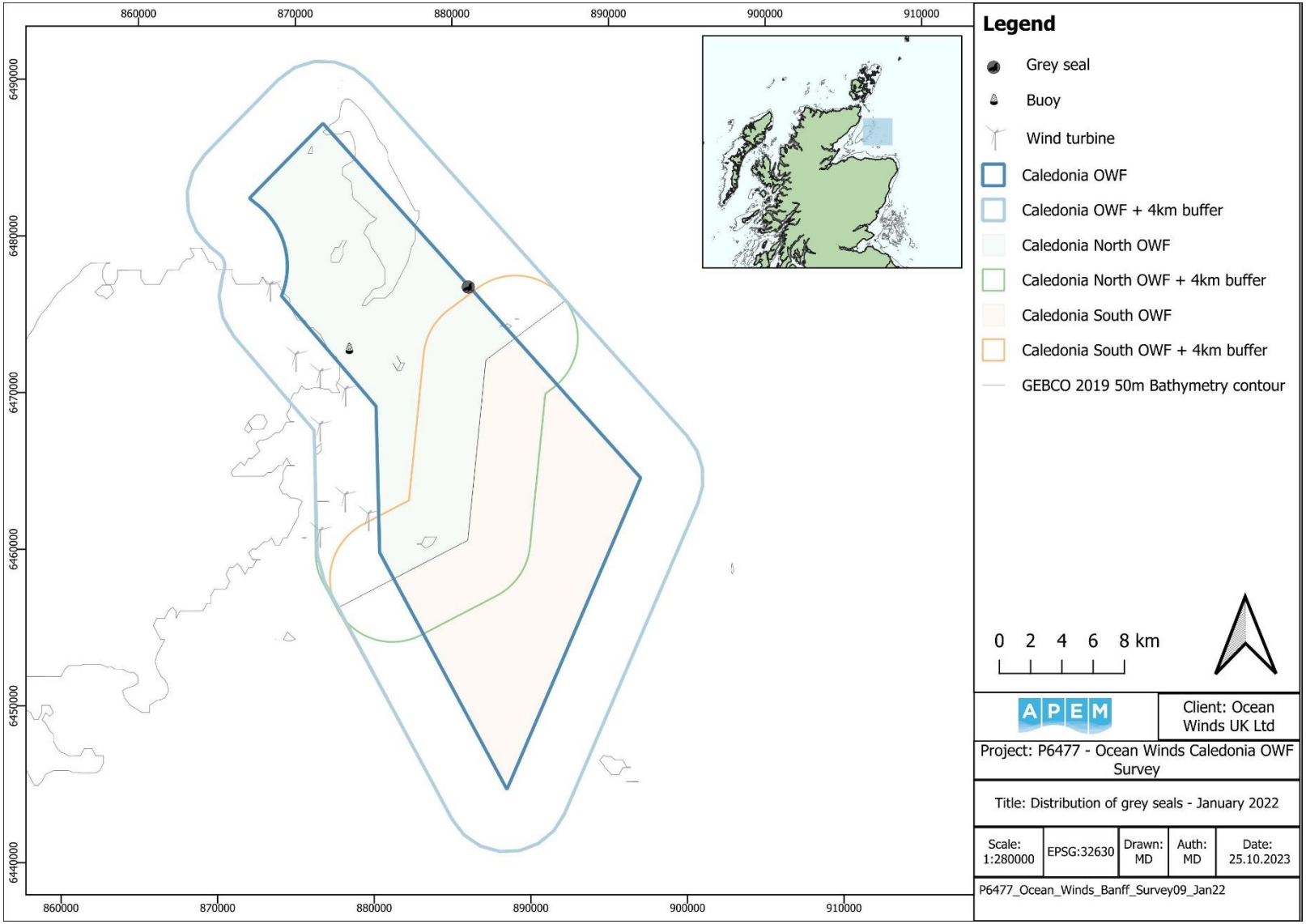



**Figure A4.355 Distribution of grey seals recorded in the Survey Area in January 2022**

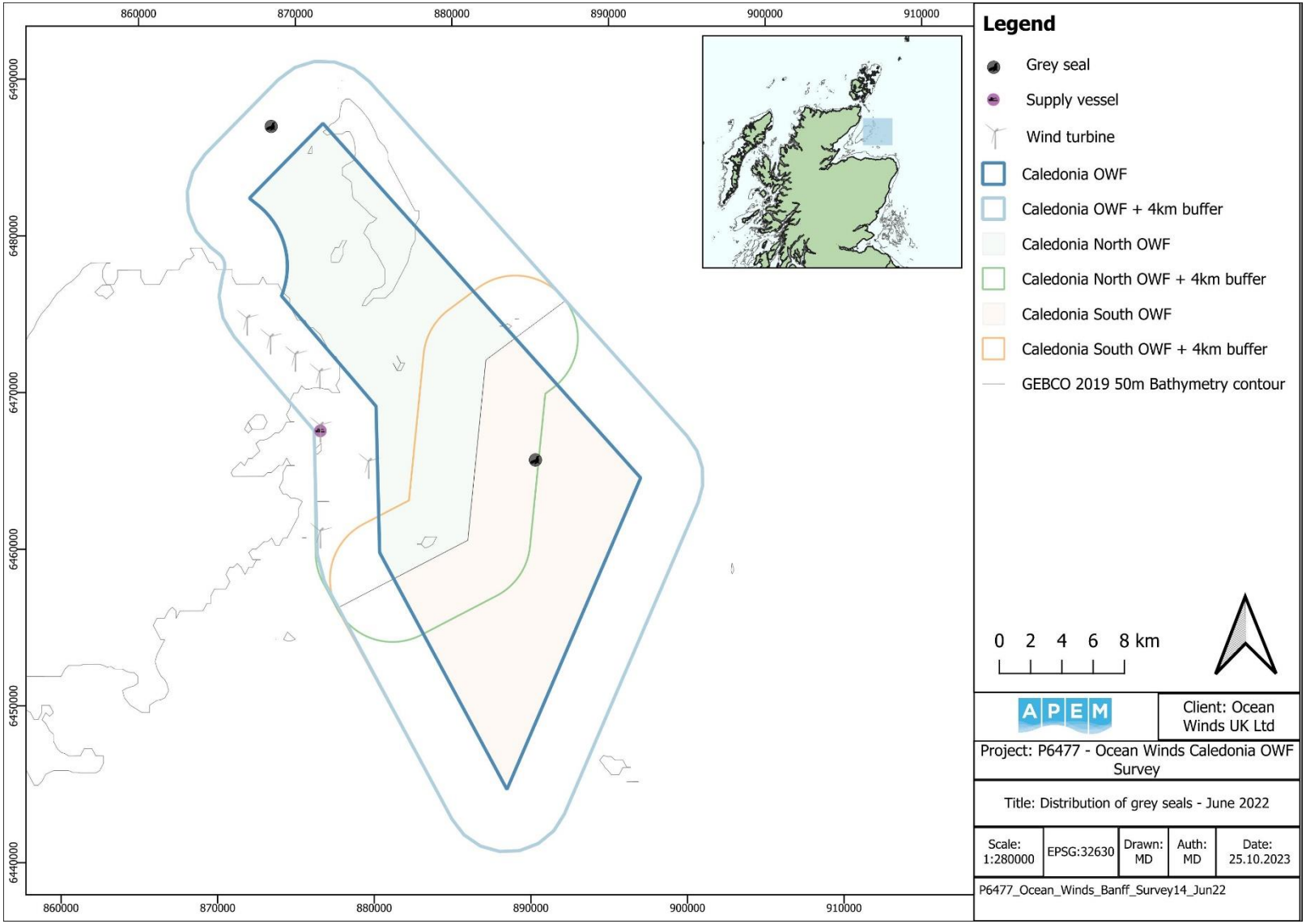



**Figure A4.356 Distribution of grey seals recorded in the Survey Area in June 2022**

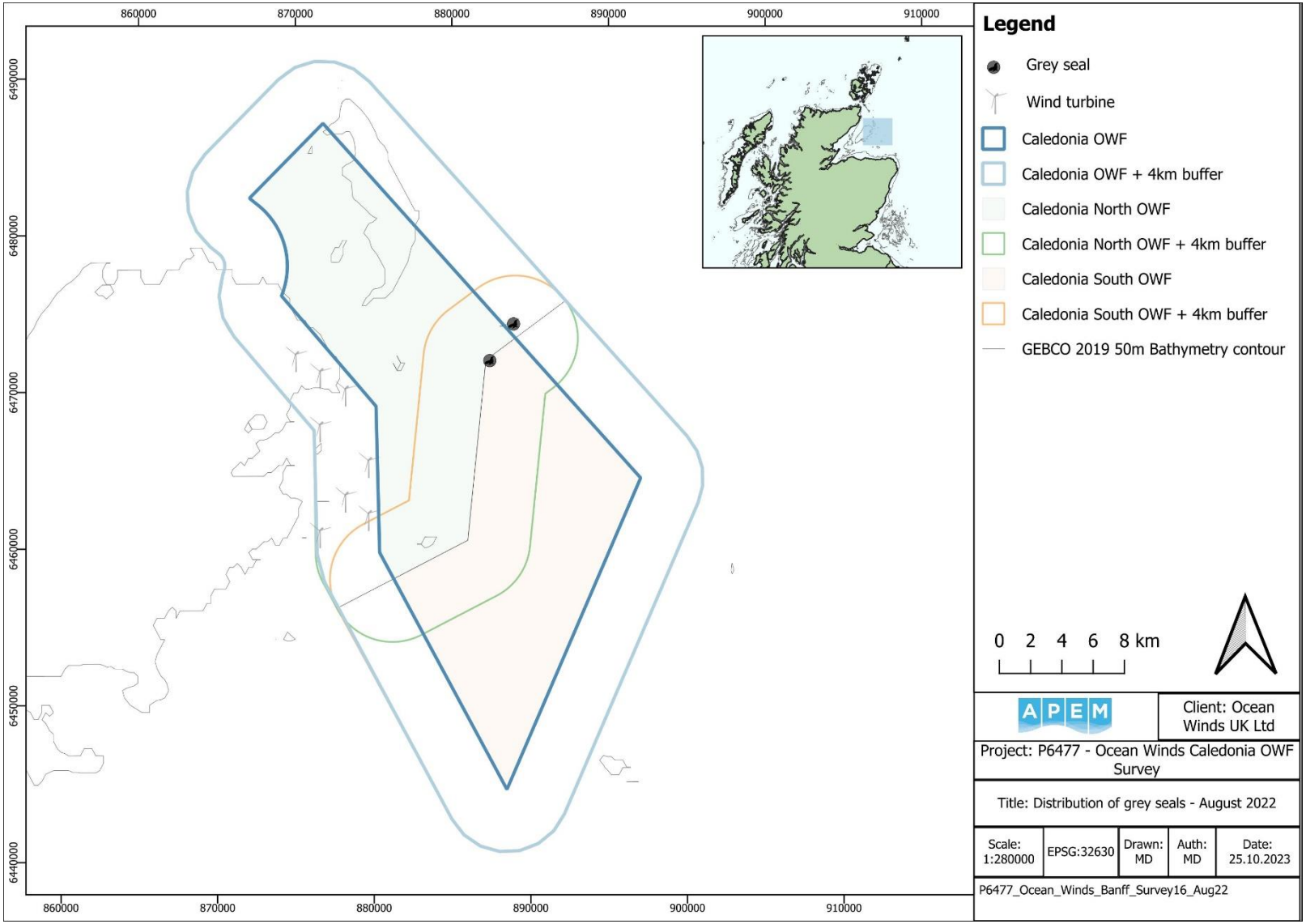



**Figure A4.357 Distribution of grey seals recorded in the Survey Area in August 2022**

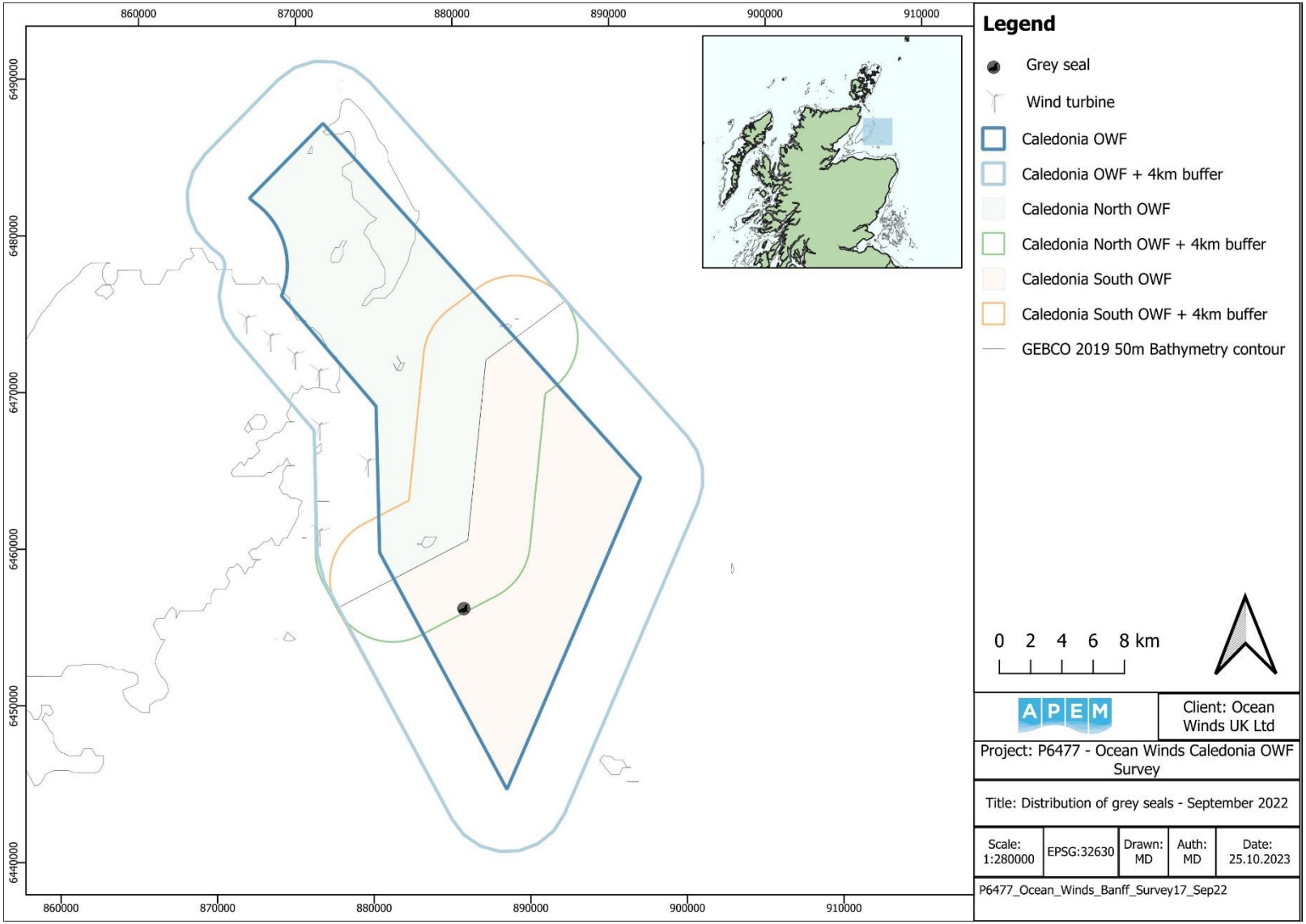



**Figure A4.358 Distribution of grey seals recorded in the Survey Area in September 2022**

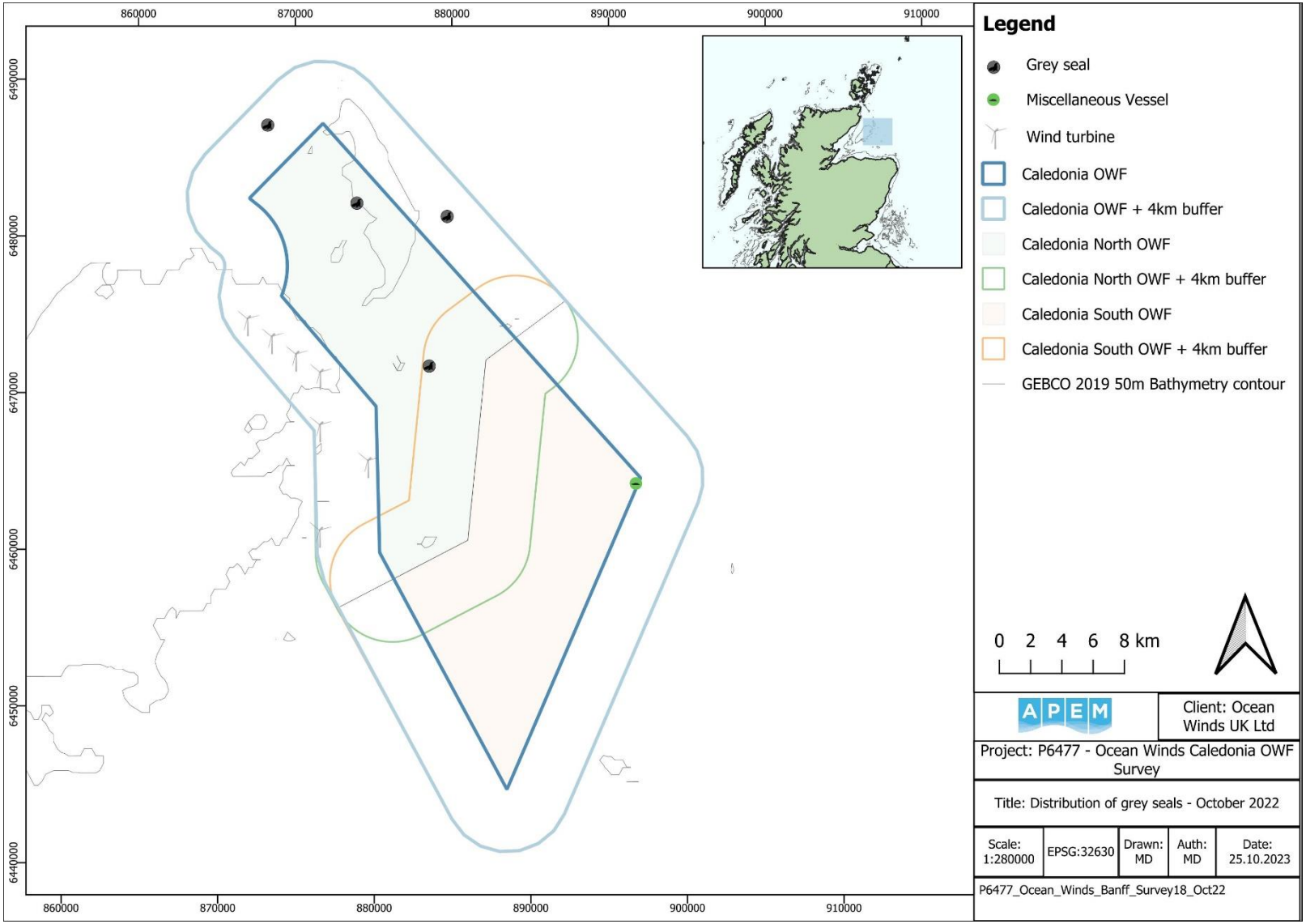



**Figure A4.359 Distribution of grey seals recorded in the Survey Area in October 2022**

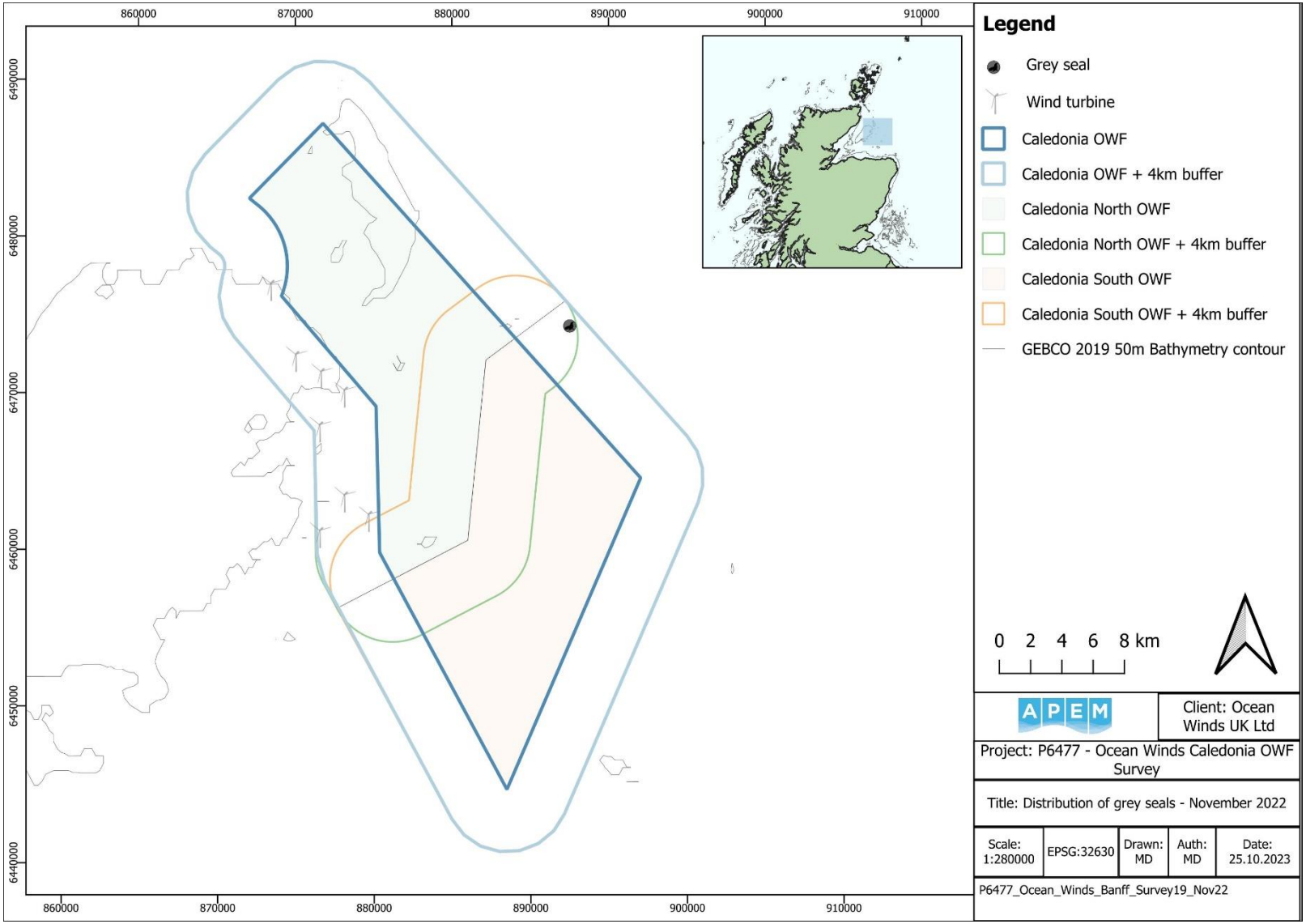



**Figure A4.360 Distribution of grey seals recorded in the Survey Area in November 2022**

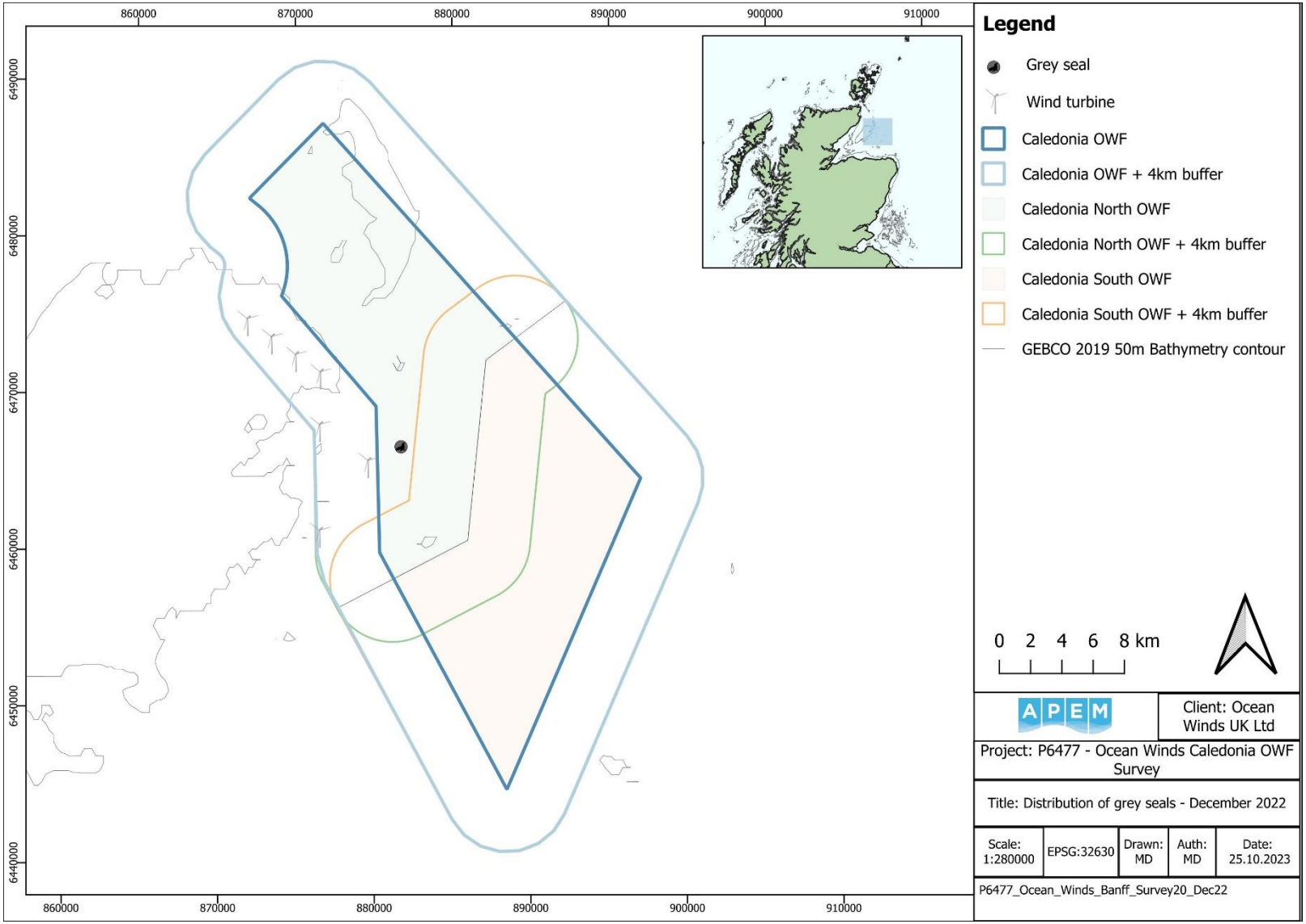



**Figure A4.361 Distribution of grey seals recorded in the Survey Area in December 2022**

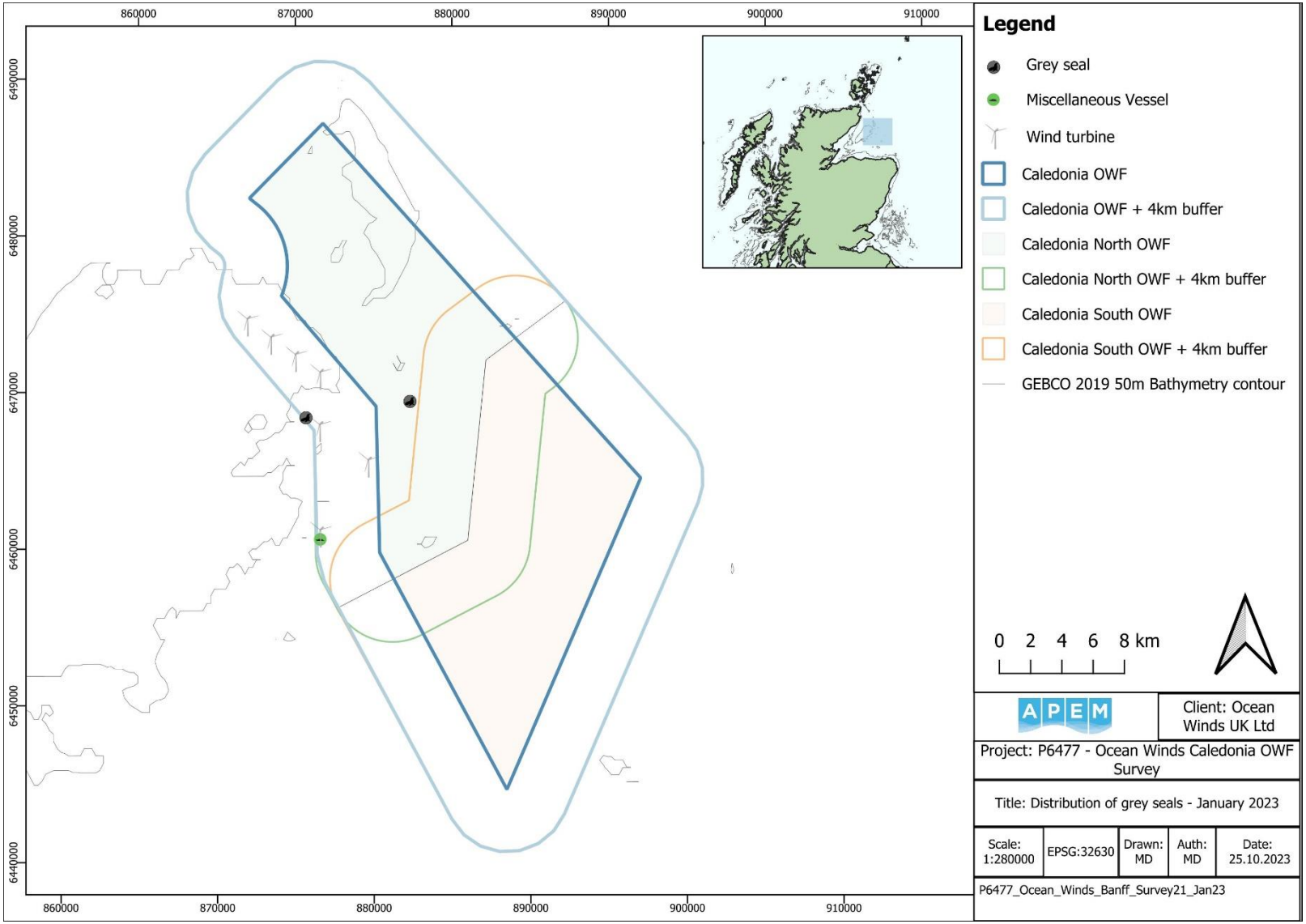



**Figure A4.362 Distribution of grey seals recorded in the Survey Area in January 2023**

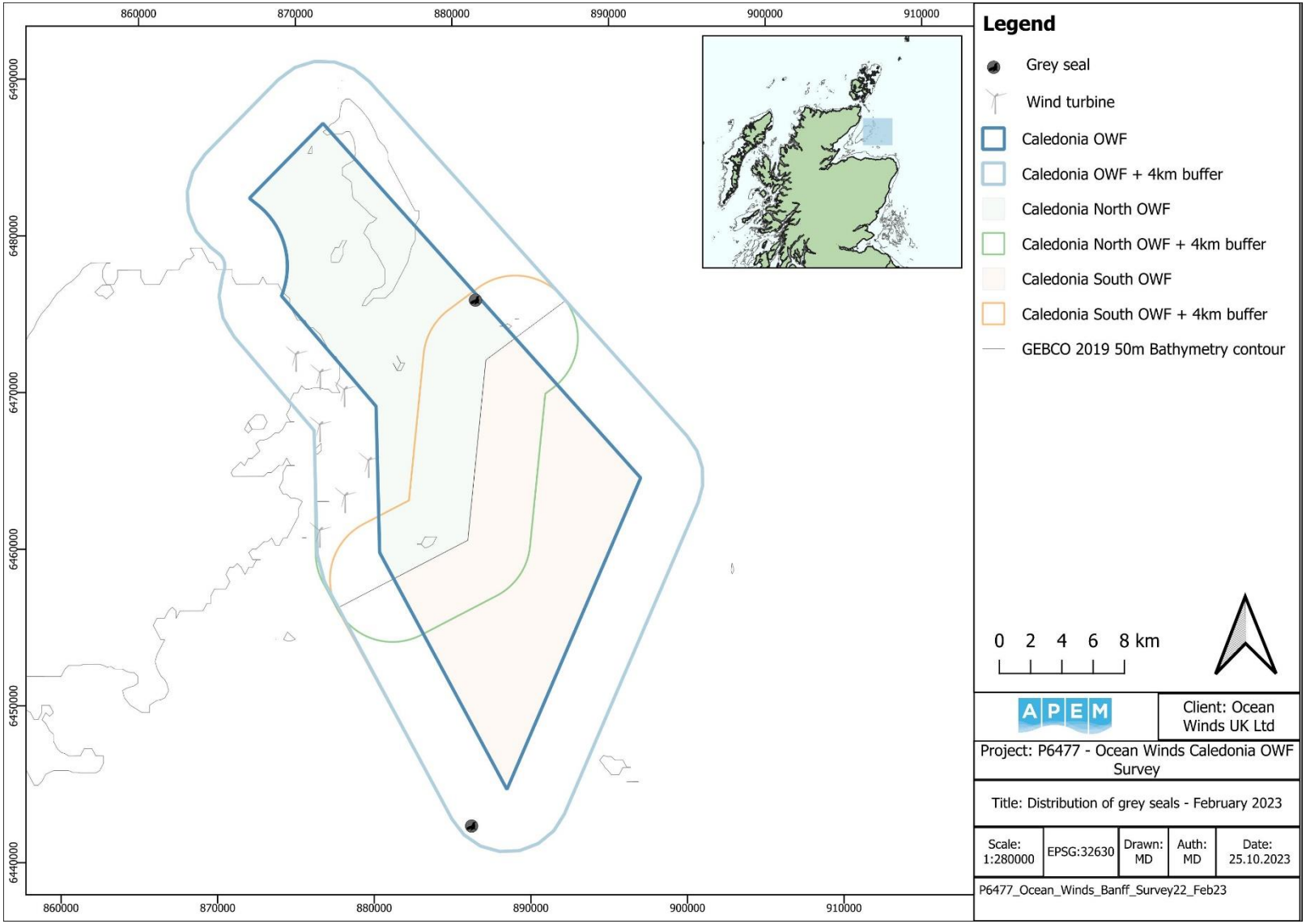



**Figure A4.363 Distribution of grey seals recorded in the Survey Area in February 2023**

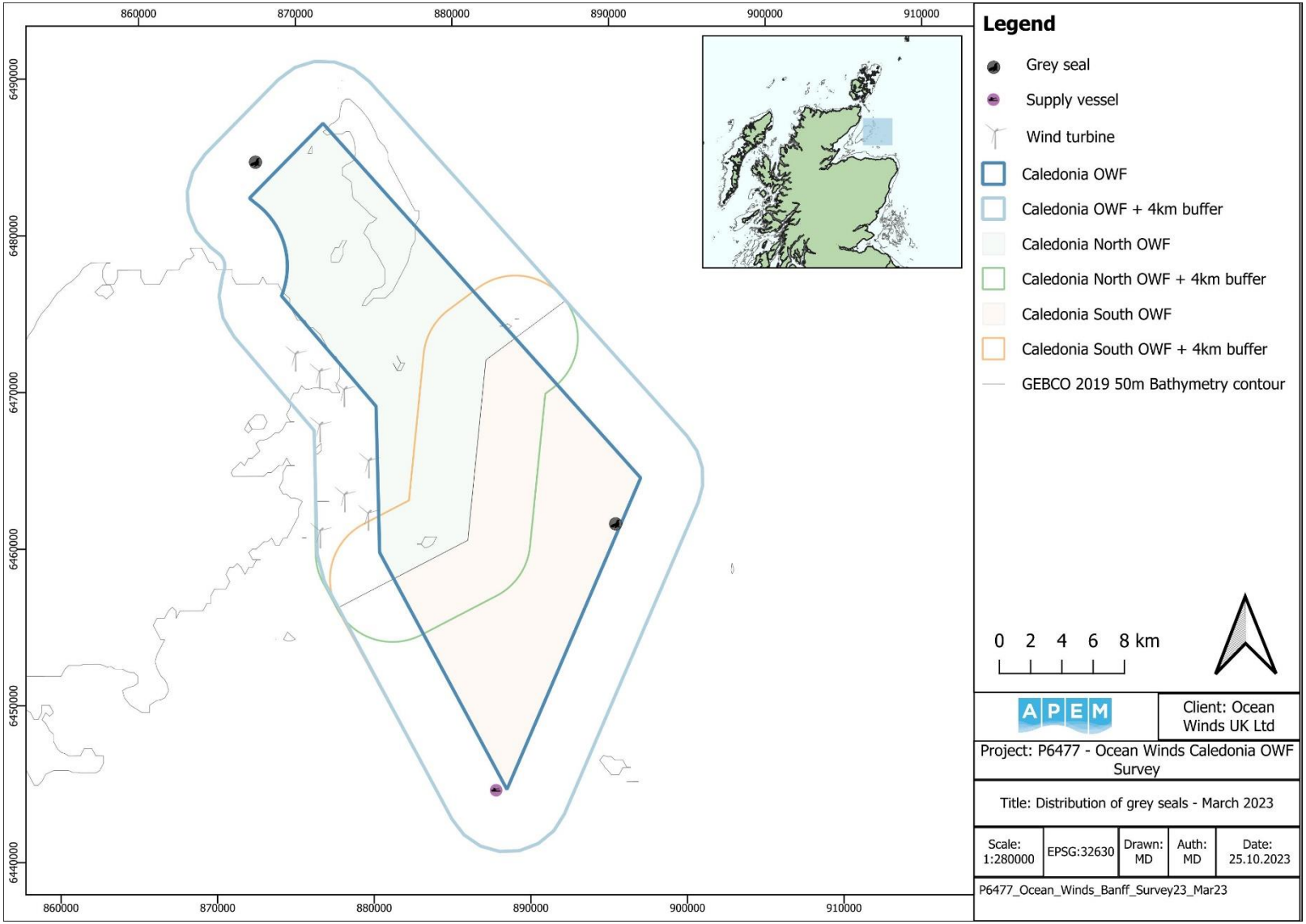



**Figure A4.364 Distribution of grey seals recorded in the Survey Area in March 2023**

## Unidentified seal species

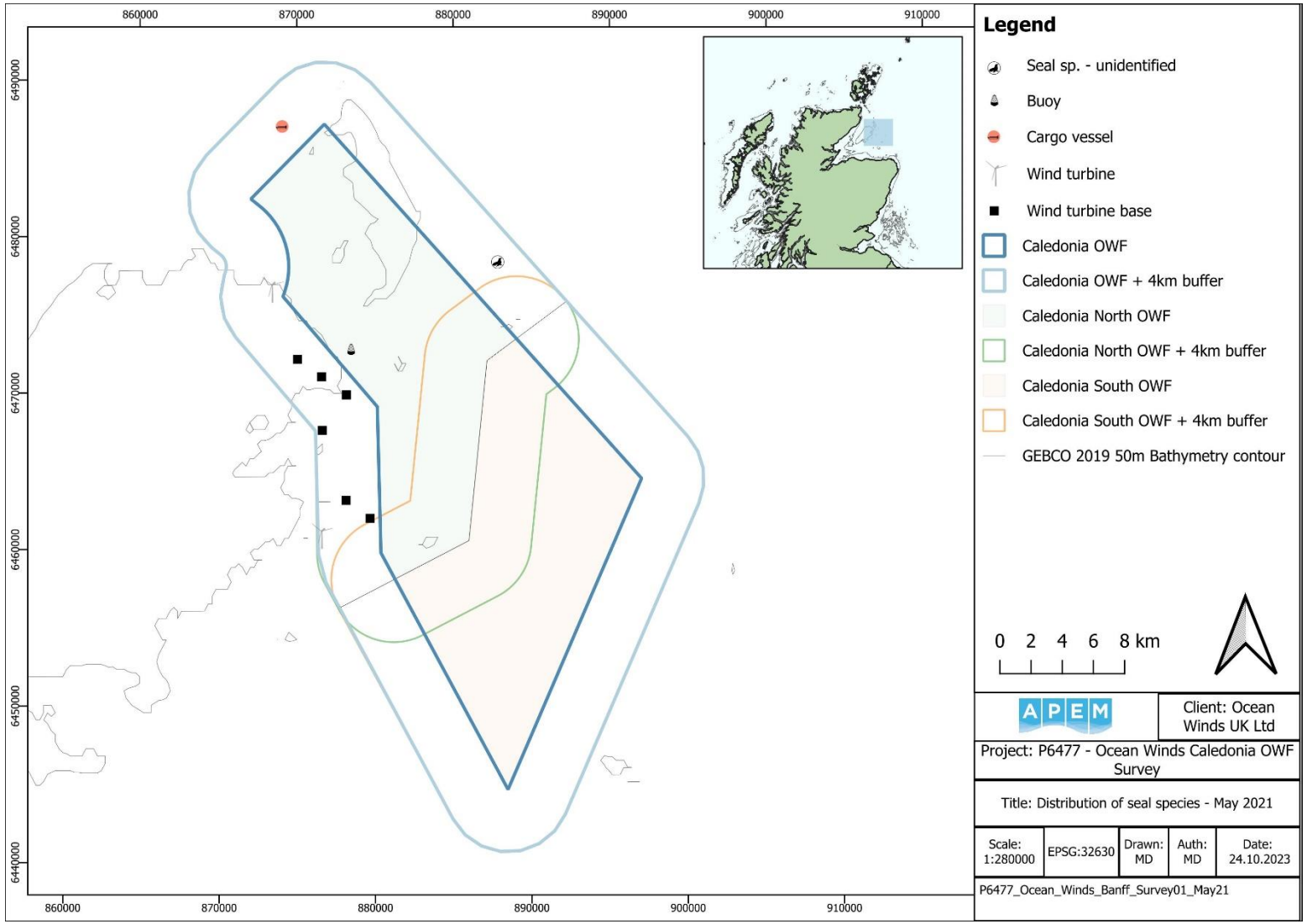



**Figure A4.365 Distribution of unidentified seal species recorded in the Survey Area in May 2021**

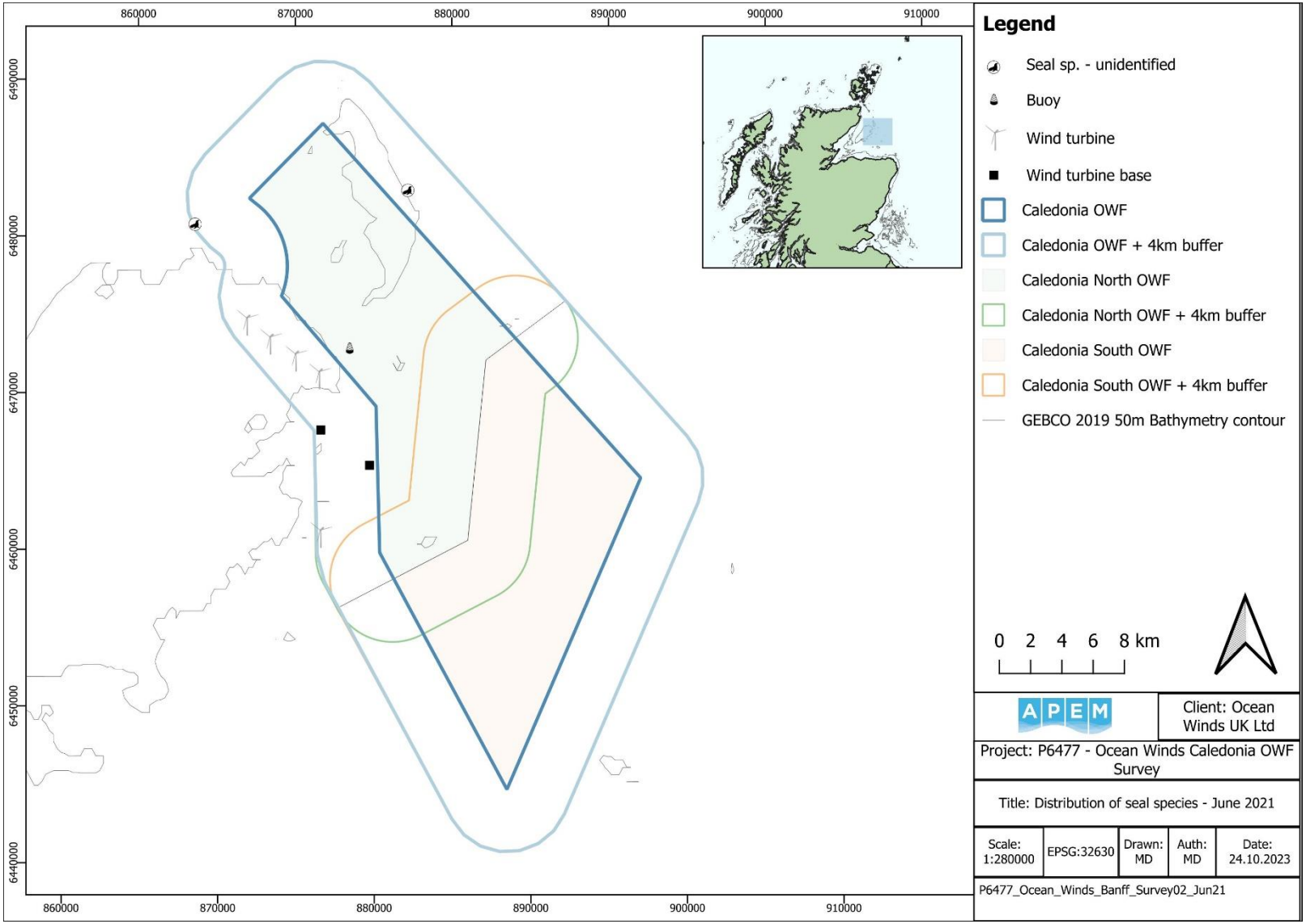



**Figure A4.366 Distribution of unidentified seal species recorded in the Survey Area in June 2021**

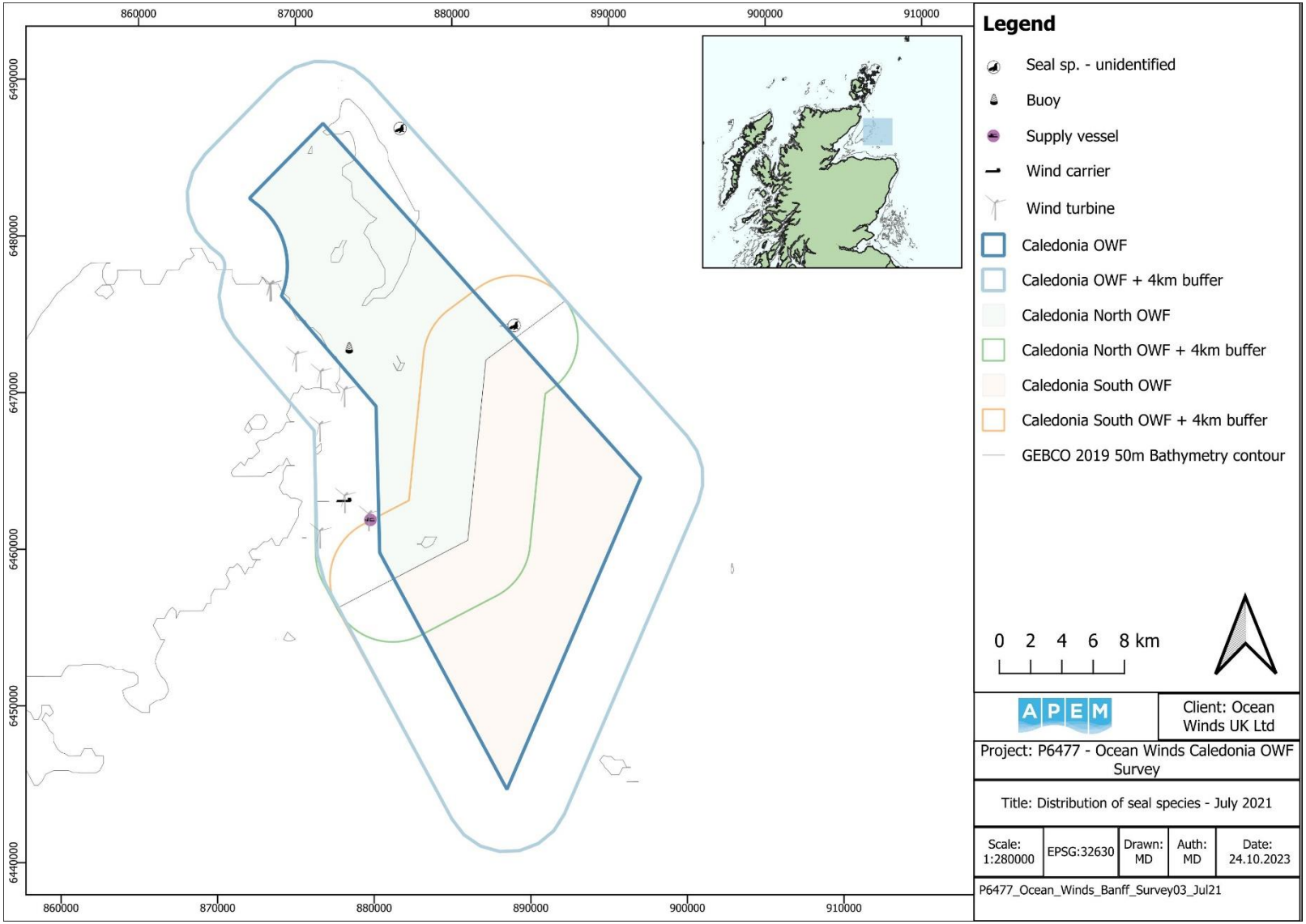



**Figure A4.367 Distribution of unidentified seal species recorded in the Survey Area in July 2021**

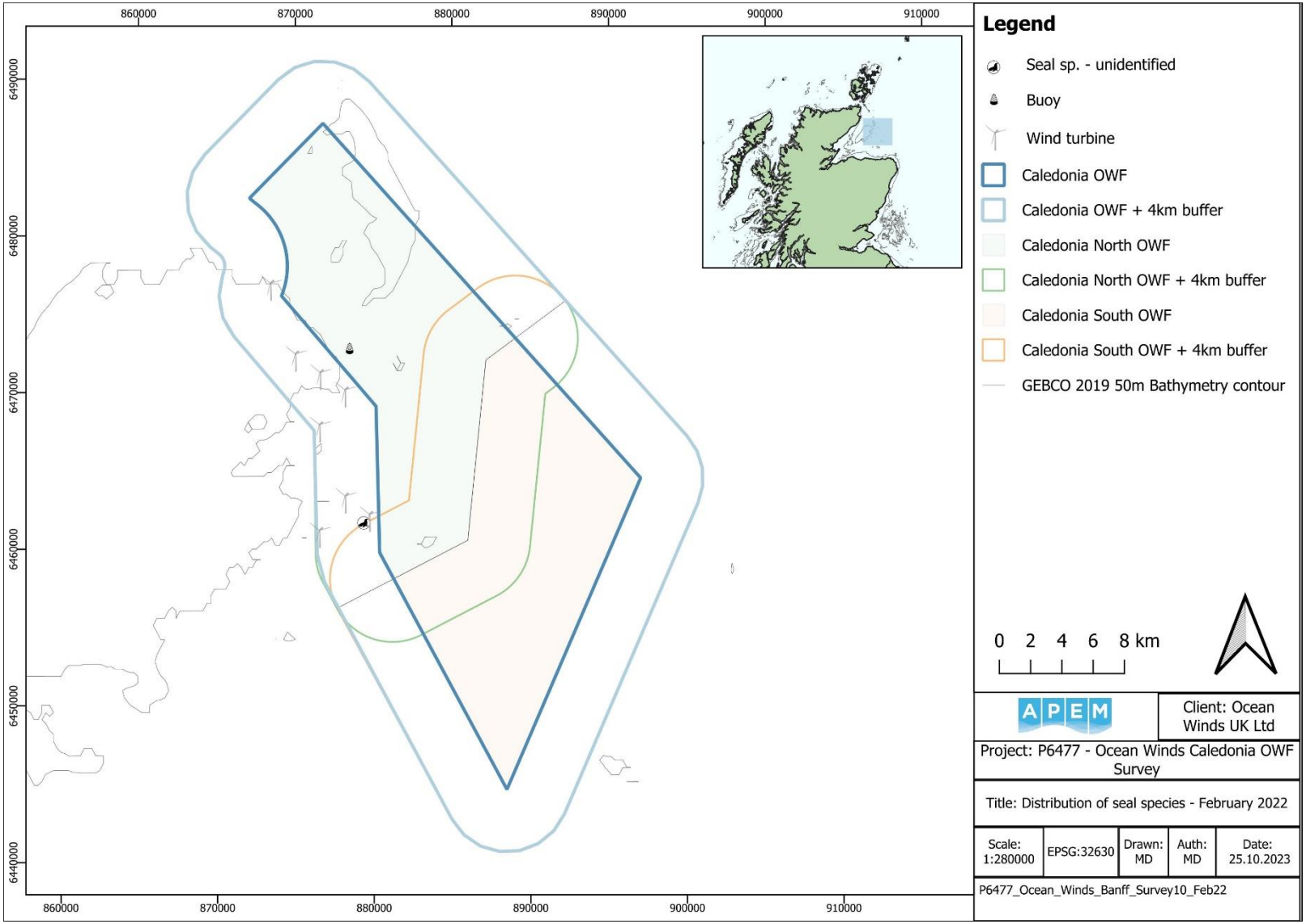



**Figure A4.368 Distribution of unidentified seal species recorded in the Survey Area in February 2022**

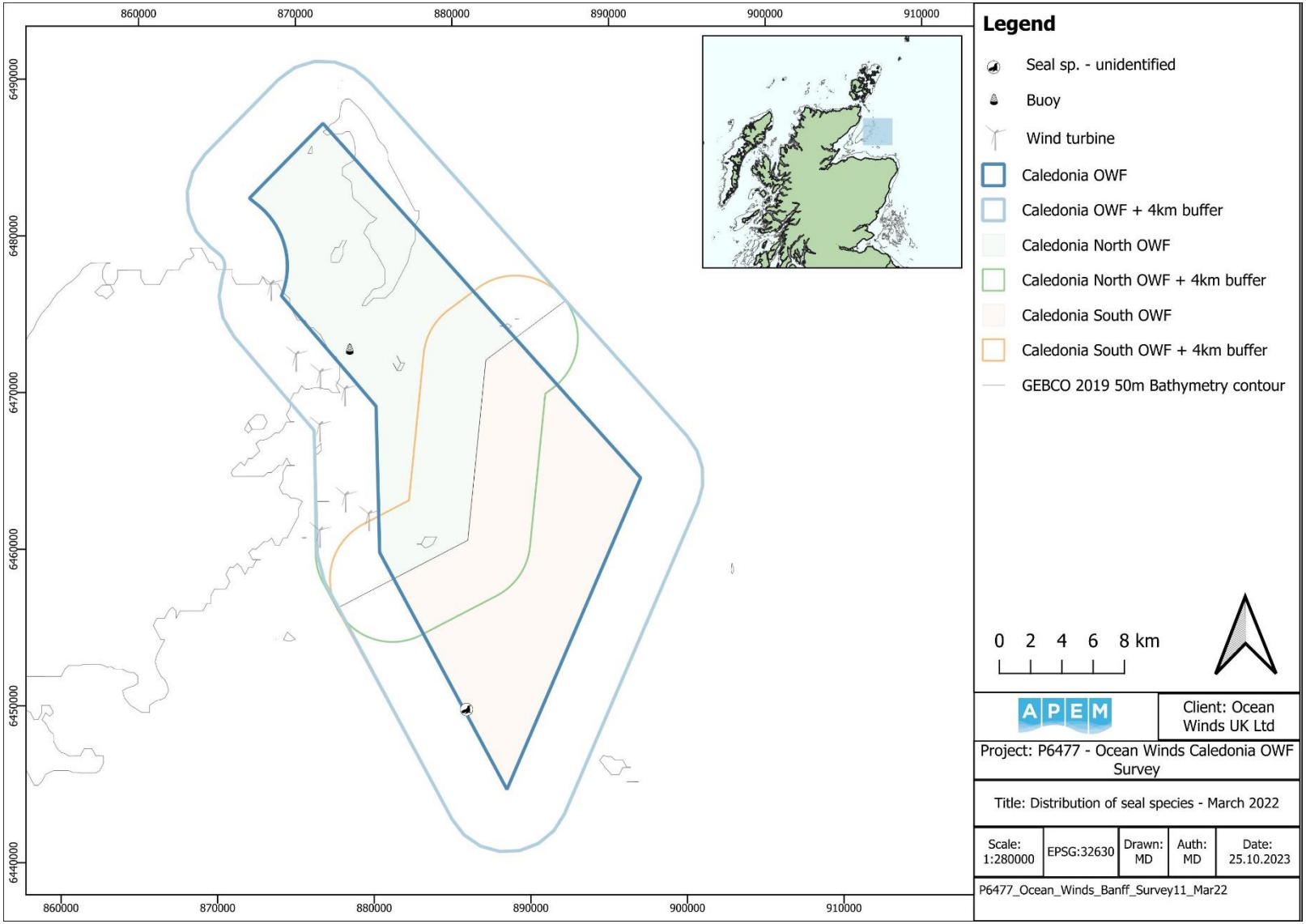



**Figure A4.369 Distribution of unidentified seal species recorded in the Survey Area in March 2022**

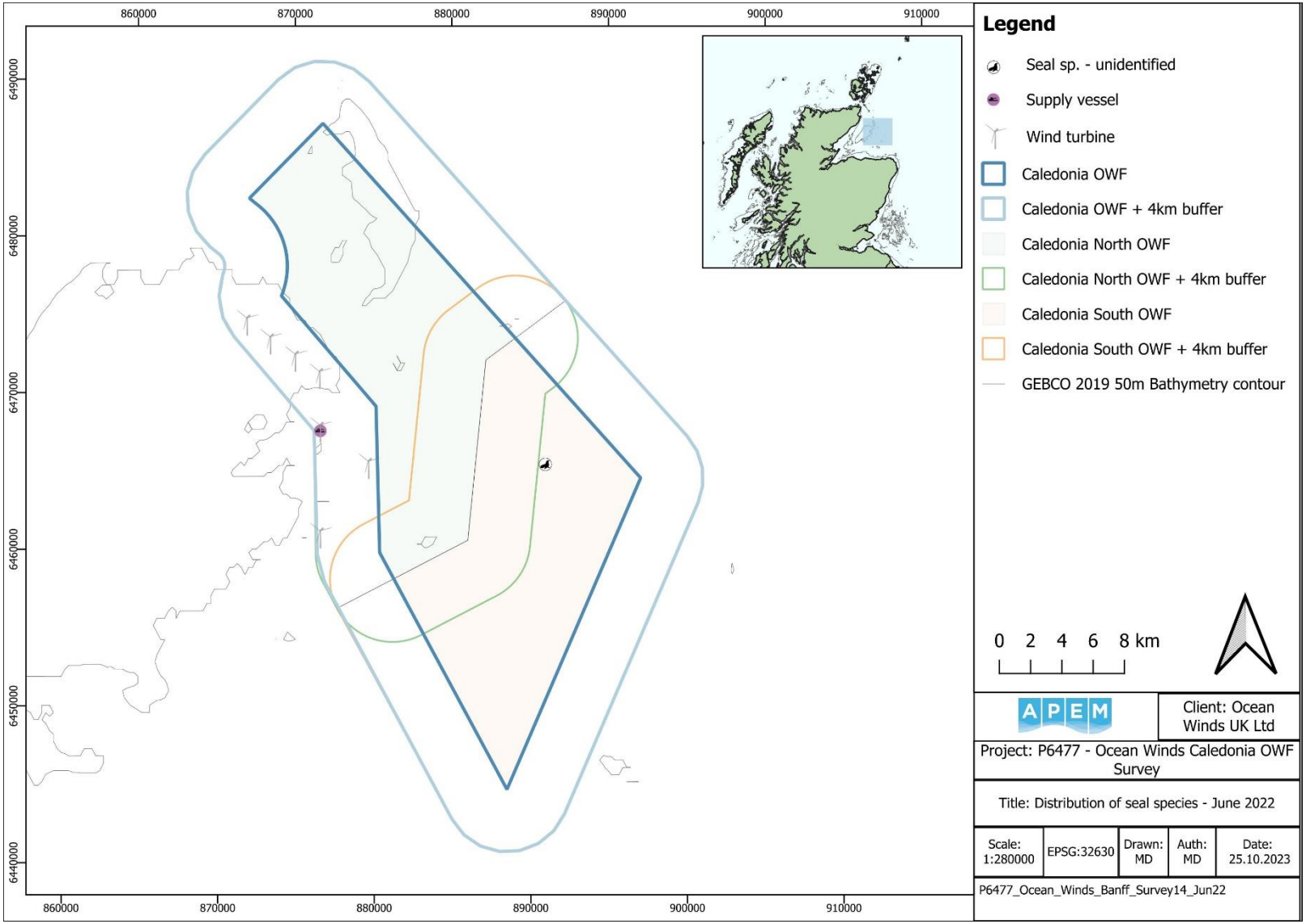



**Figure A4.370 Distribution of unidentified seal species recorded in the Survey Area in June 2022**

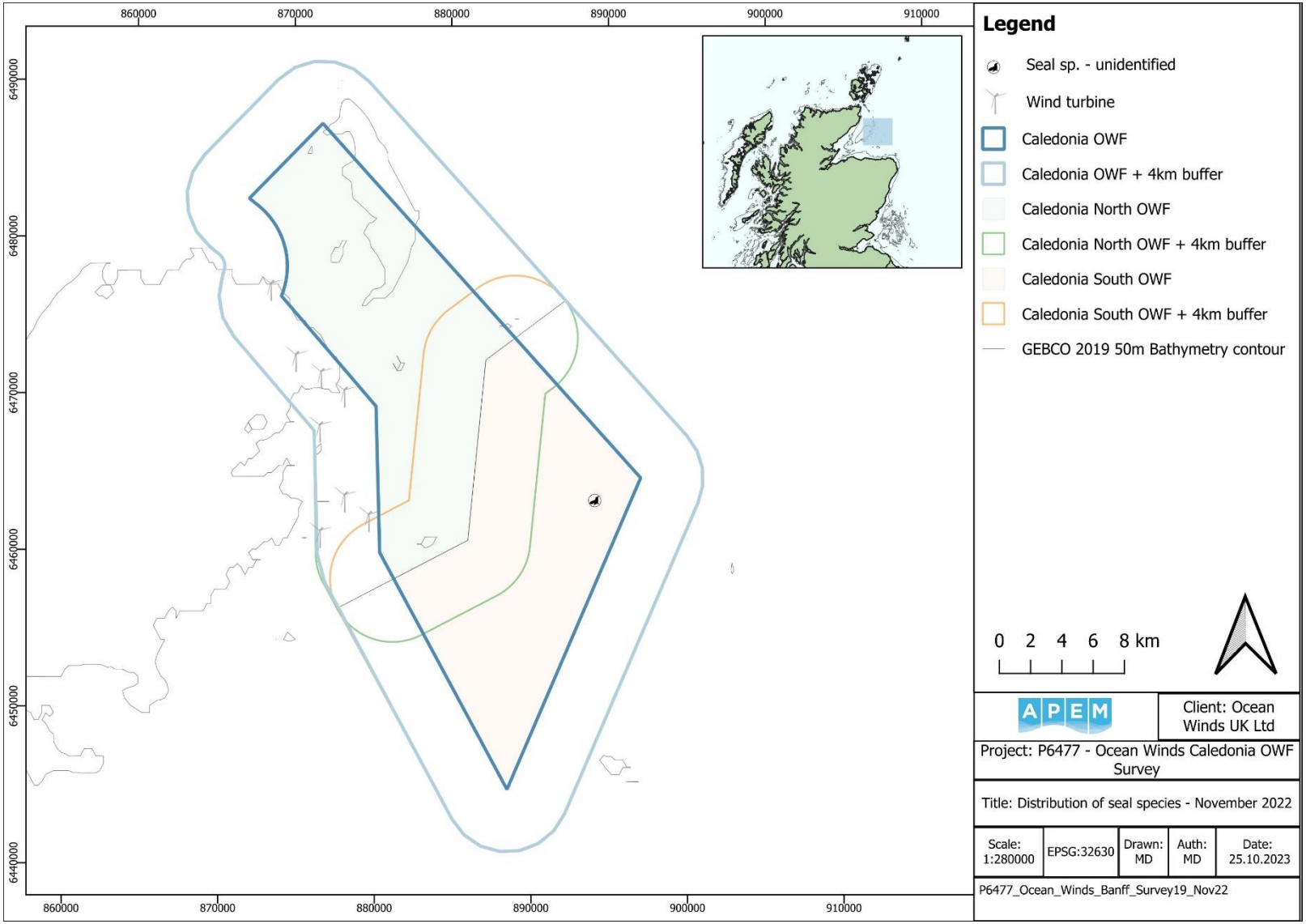



**Figure A4.371 Distribution of unidentified seal species recorded in the Survey Area in November 2022**

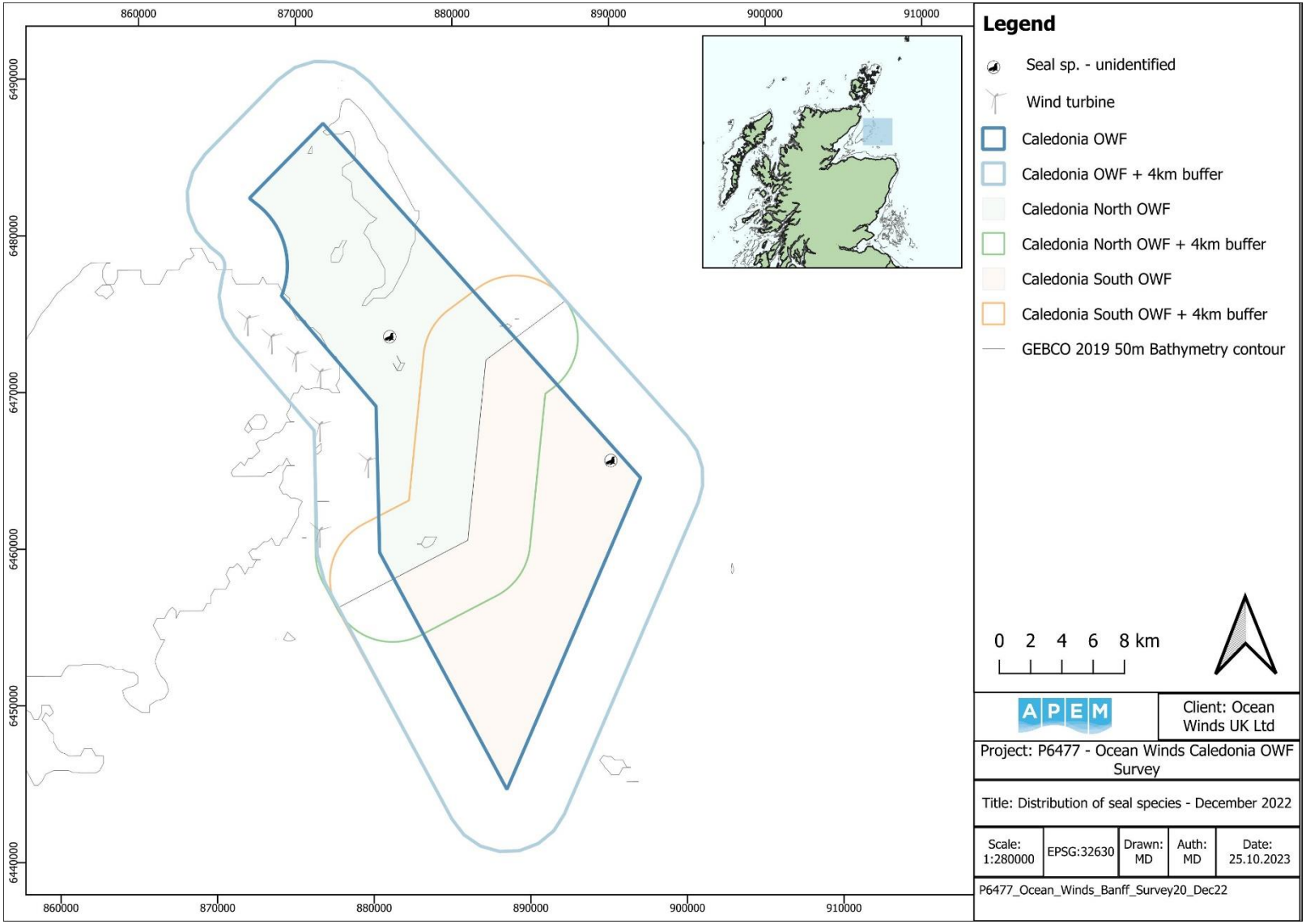



**Figure A4.372 Distribution of unidentified seal species recorded in the Survey Area in December 2022**

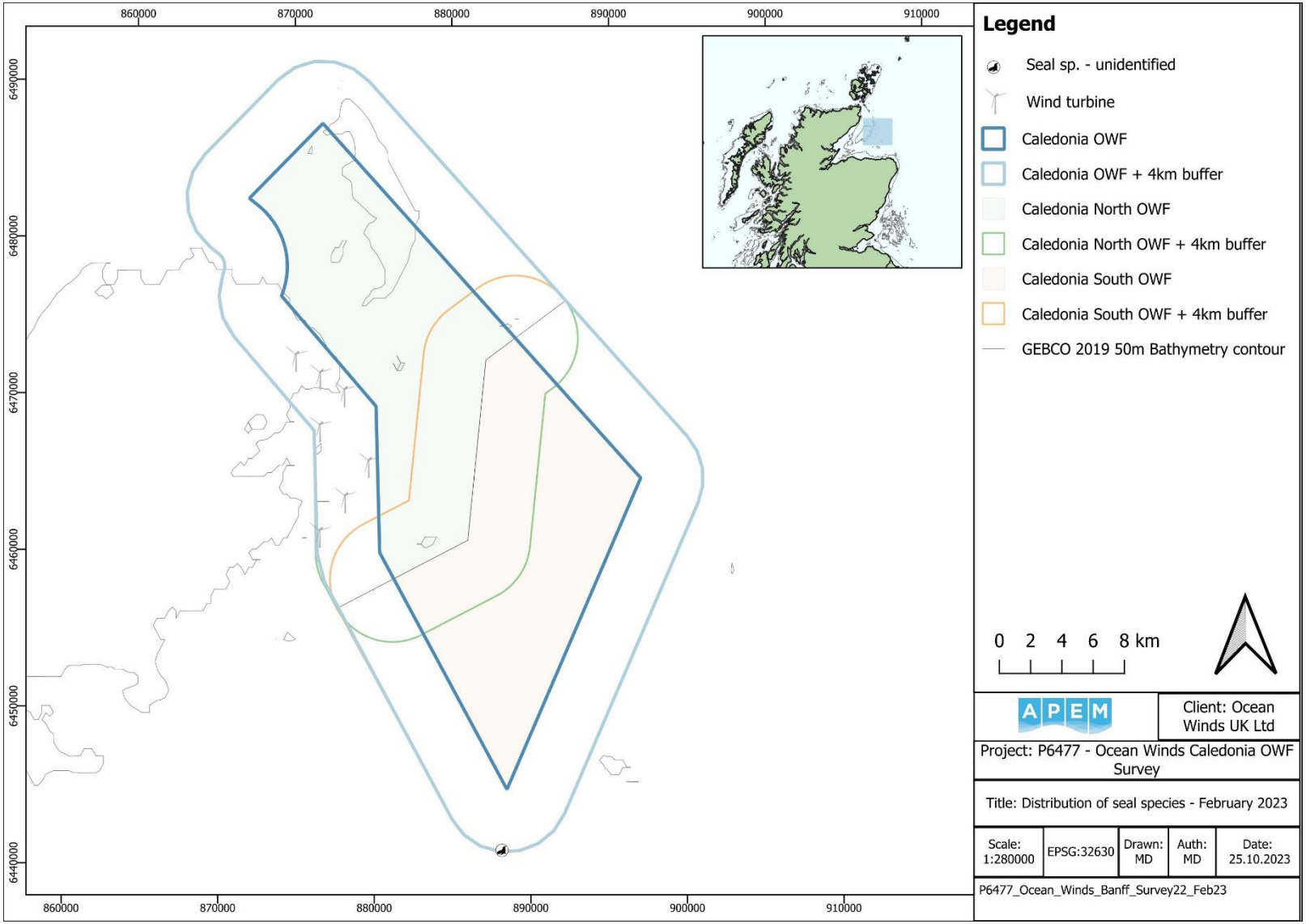



**Figure A4.373 Distribution of unidentified seal species recorded in the Survey Area in February 2023**

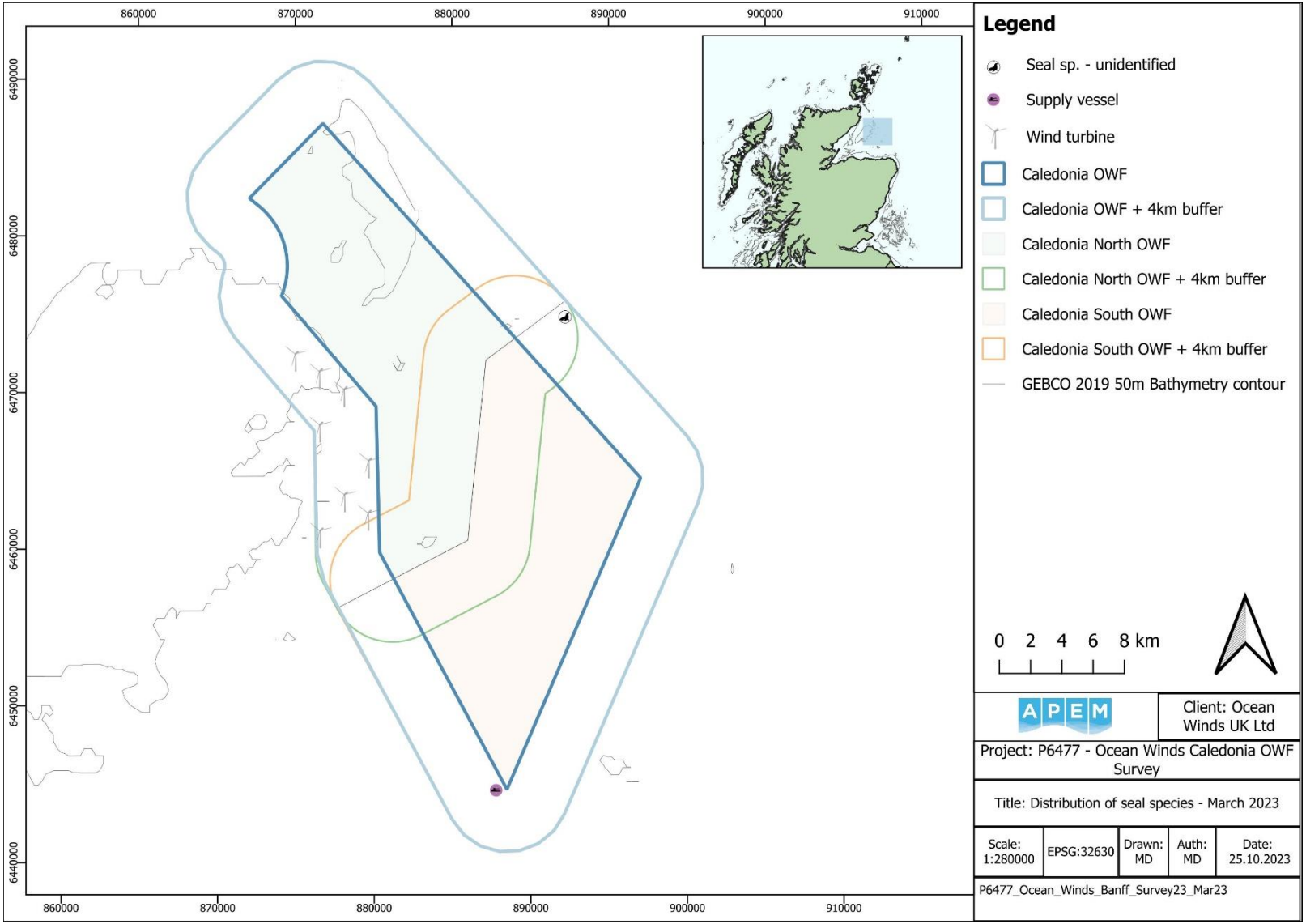



**Figure A4.374 Distribution of unidentified seal species recorded in the Survey Area in March 2023**

## Common dolphin

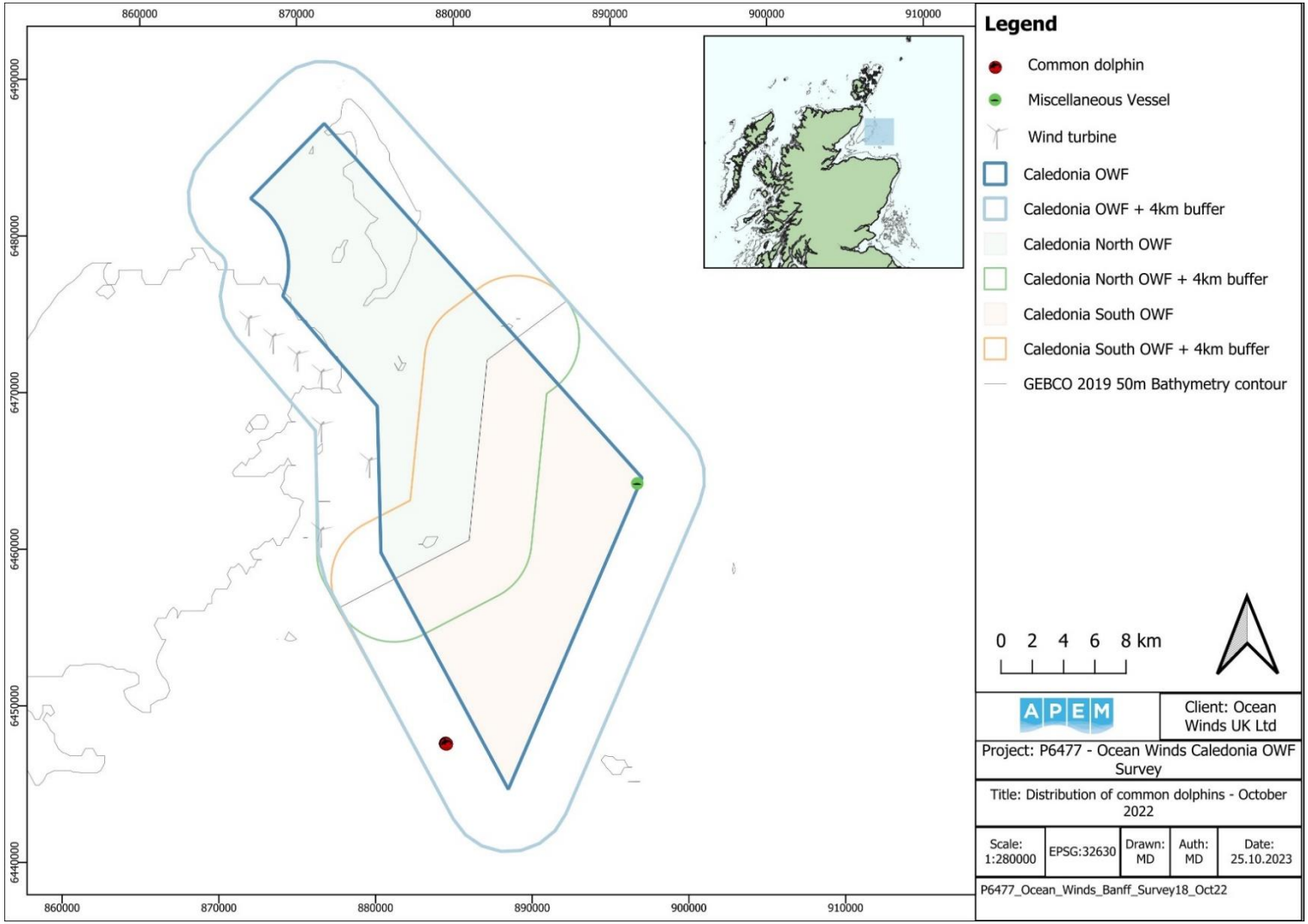



**Figure A4.375 Distribution of common dolphins recorded in the Survey Area in October 2022**

## White-beaked dolphin

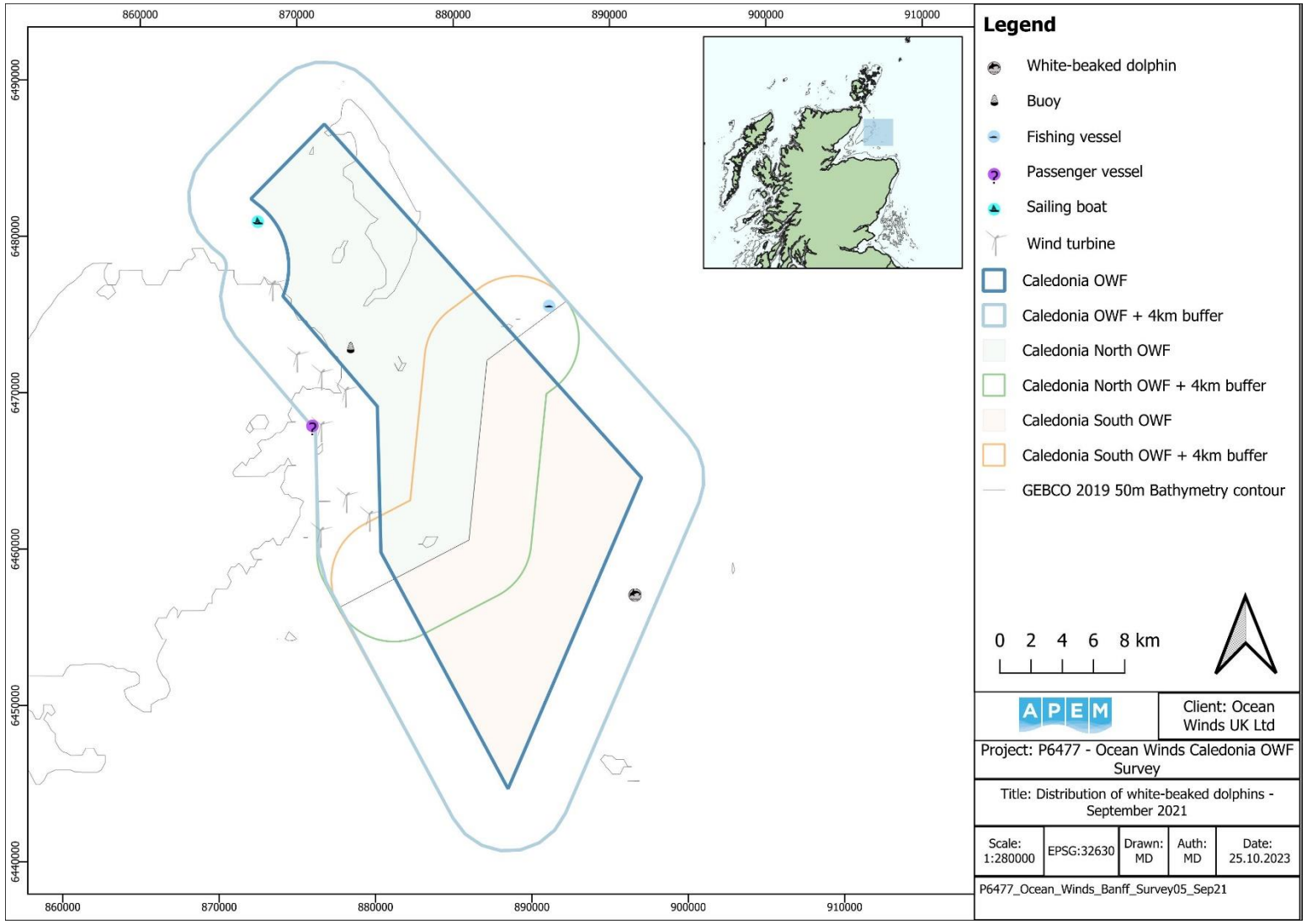



**Figure A4.376 Distribution of white-beaked dolphins recorded in the Survey Area in September 2021**

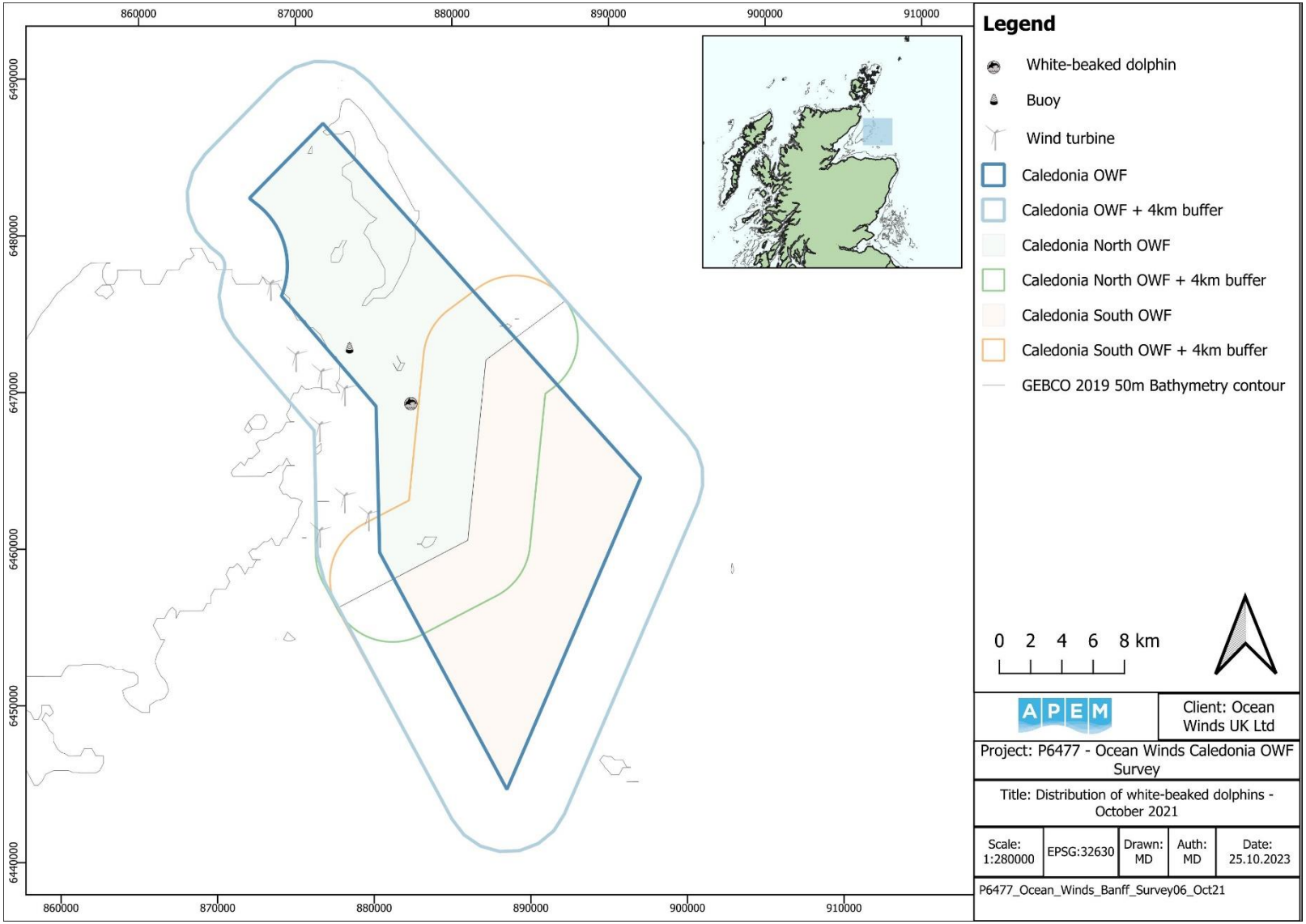



**Figure A4.377 Distribution of white-beaked dolphins recorded in the Survey Area in October 2021**

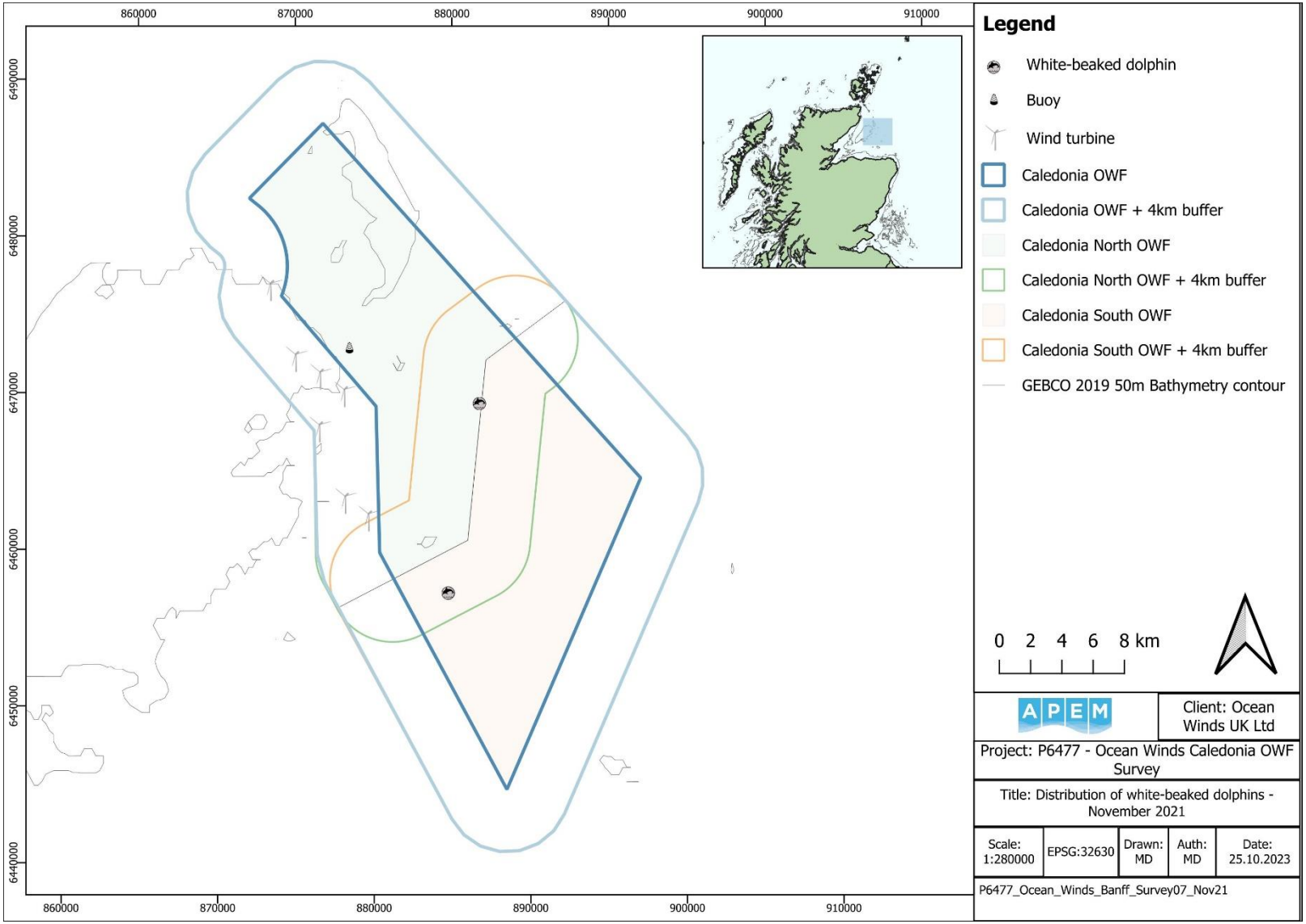



**Figure A4.378 Distribution of white-beaked dolphins recorded in the Survey Area in November 2021**

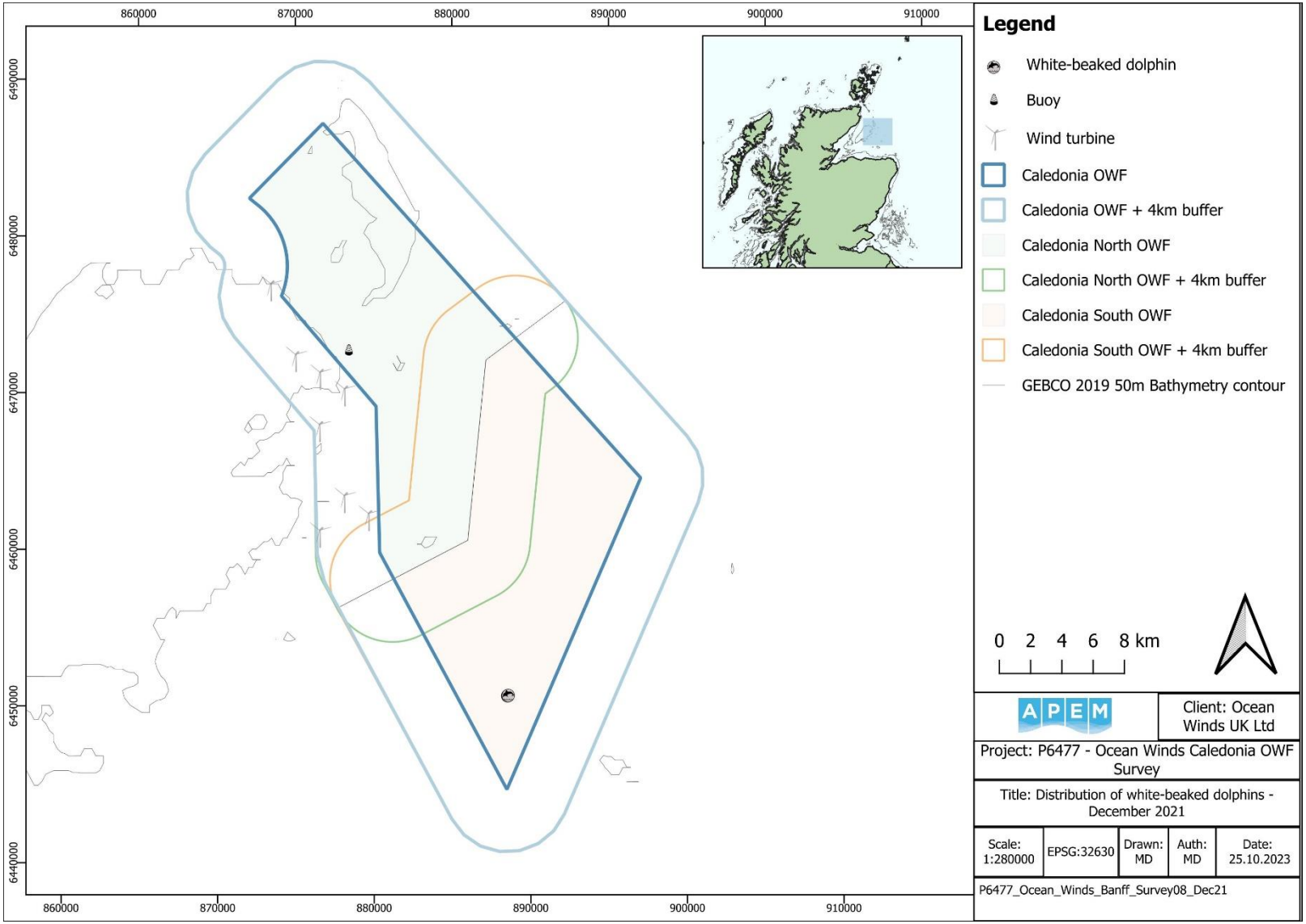



**Figure A4.379 Distribution of white-beaked dolphins recorded in the Survey Area in December 2021**

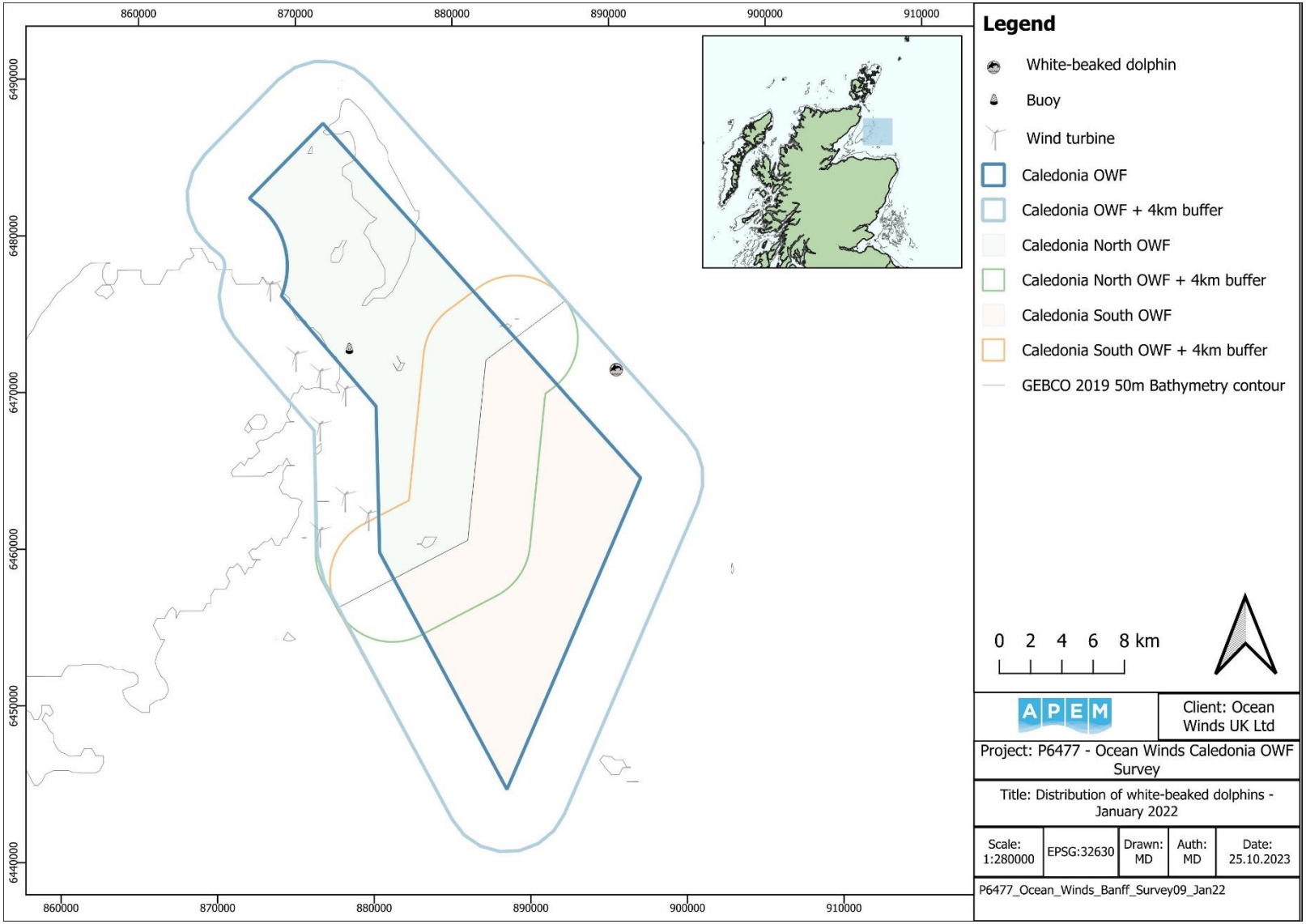



**Figure A4.380 Distribution of white-beaked dolphins recorded in the Survey Area in January 2022**

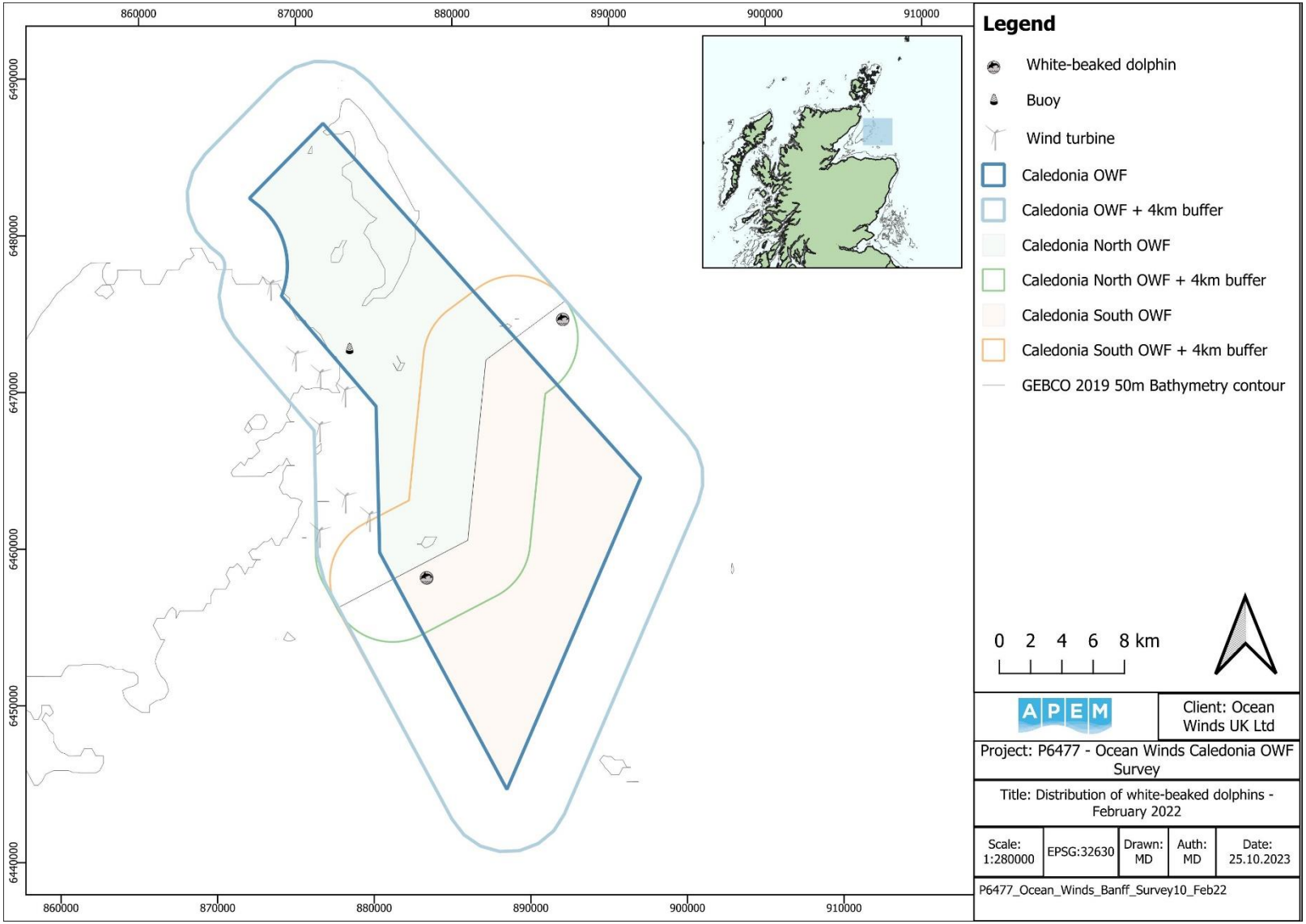



**Figure A4.381 Distribution of white-beaked dolphins recorded in the Survey Area in February 2022**

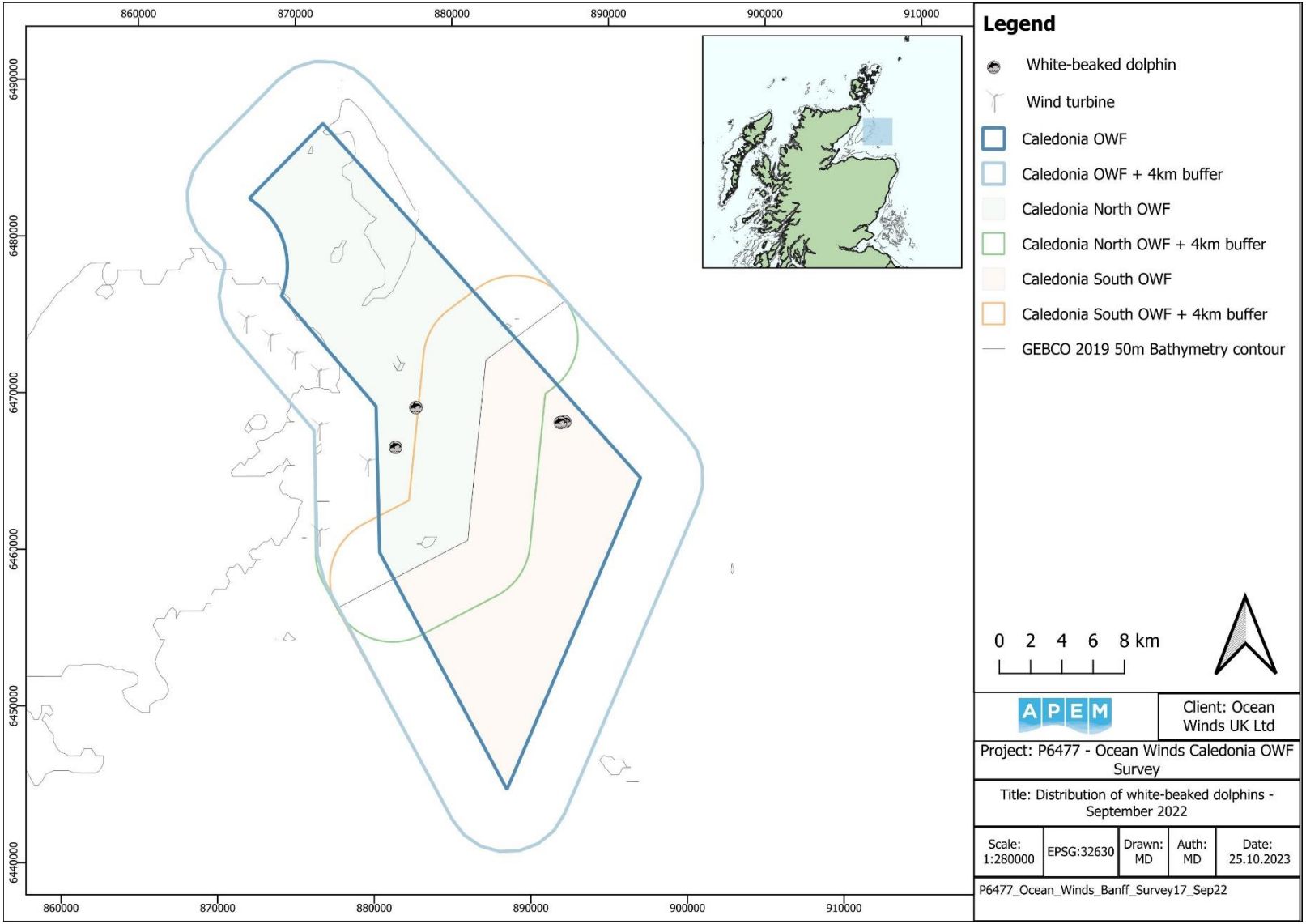



**Figure A4.382 Distribution of white-beaked dolphins recorded in the Survey Area in September 2022**

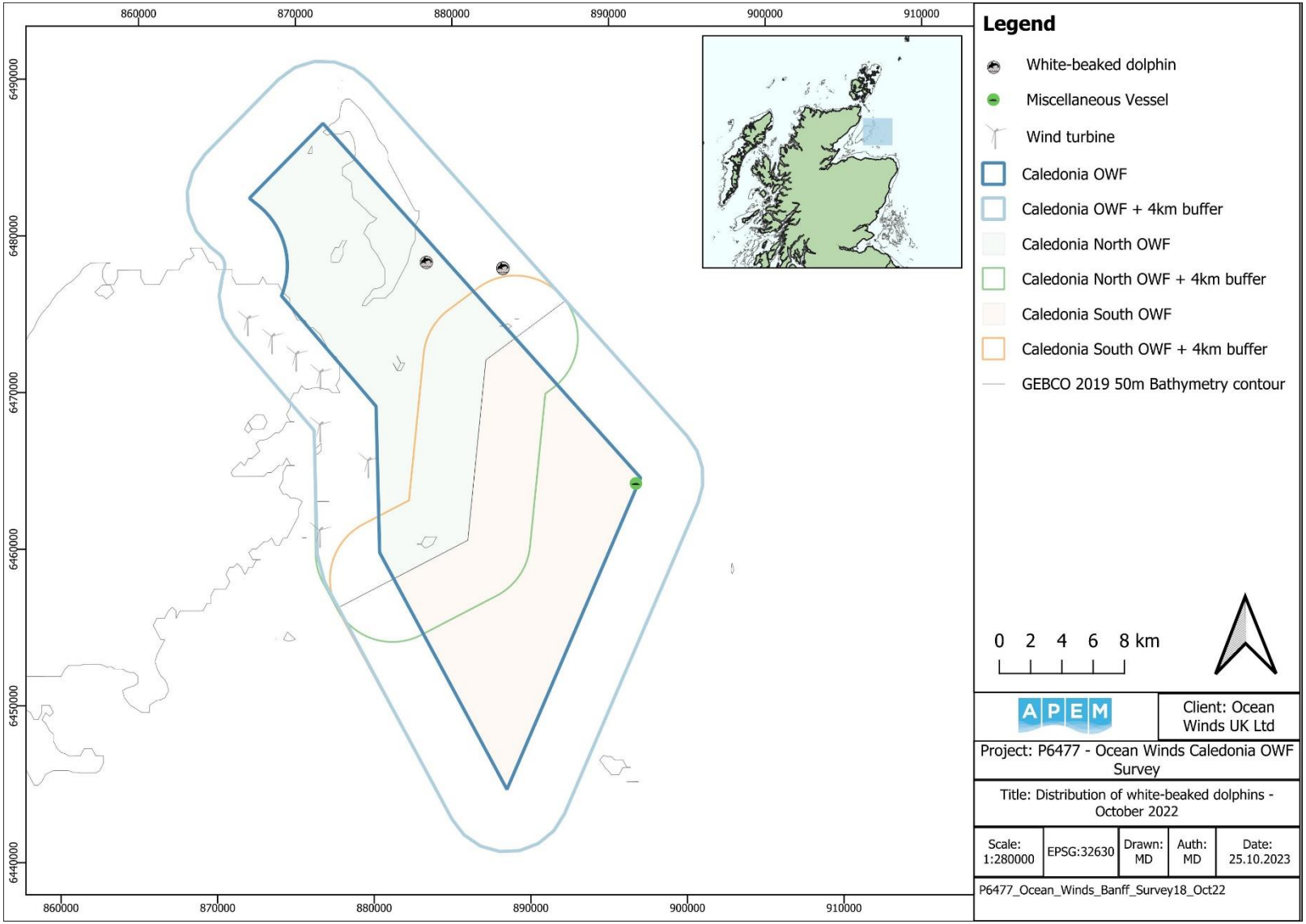



**Figure A4.383 Distribution of white-beaked dolphins recorded in the Survey Area in October 2022**

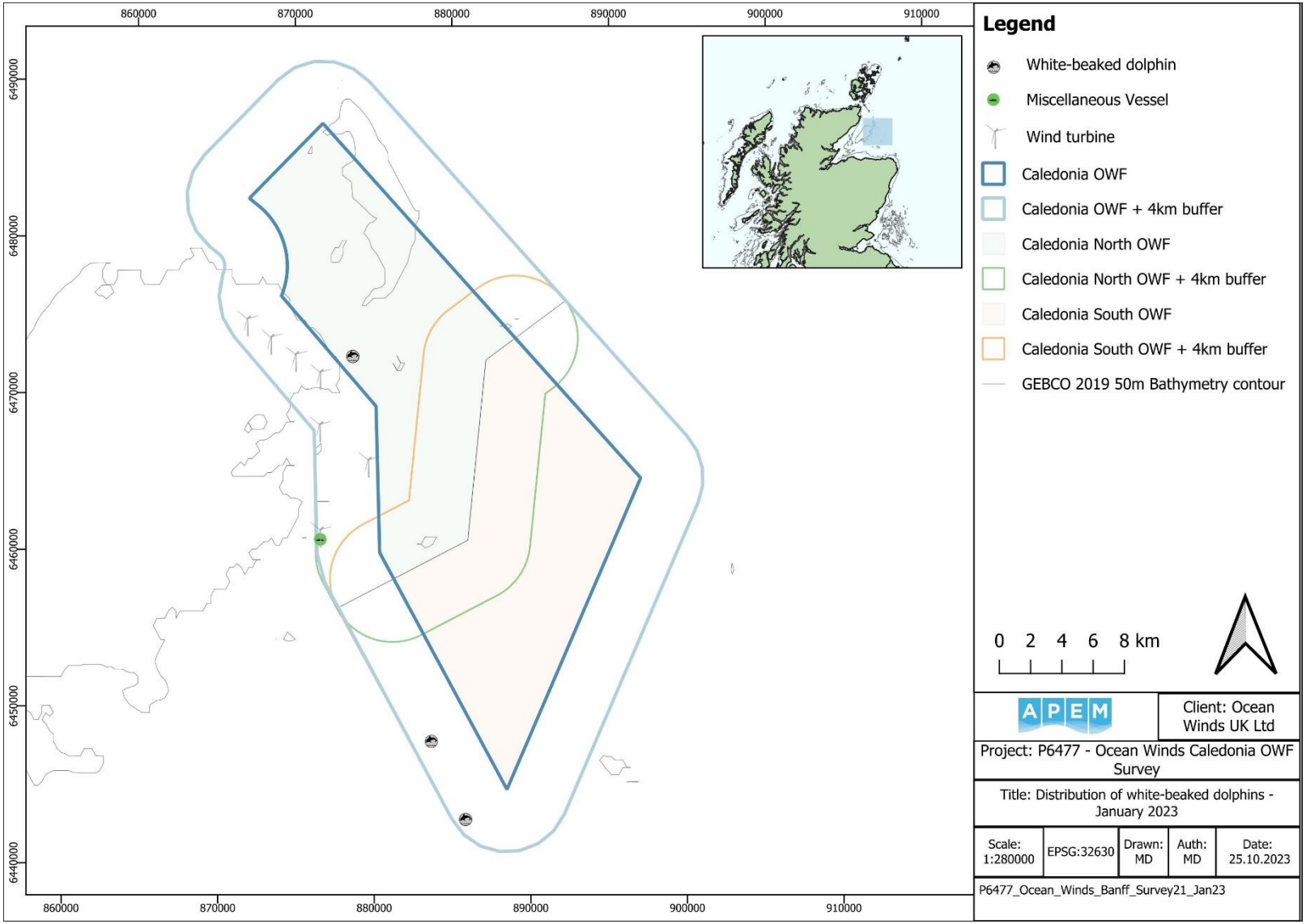



**Figure A4.384 Distribution of white-beaked dolphins recorded in the Survey Area in January 2023**

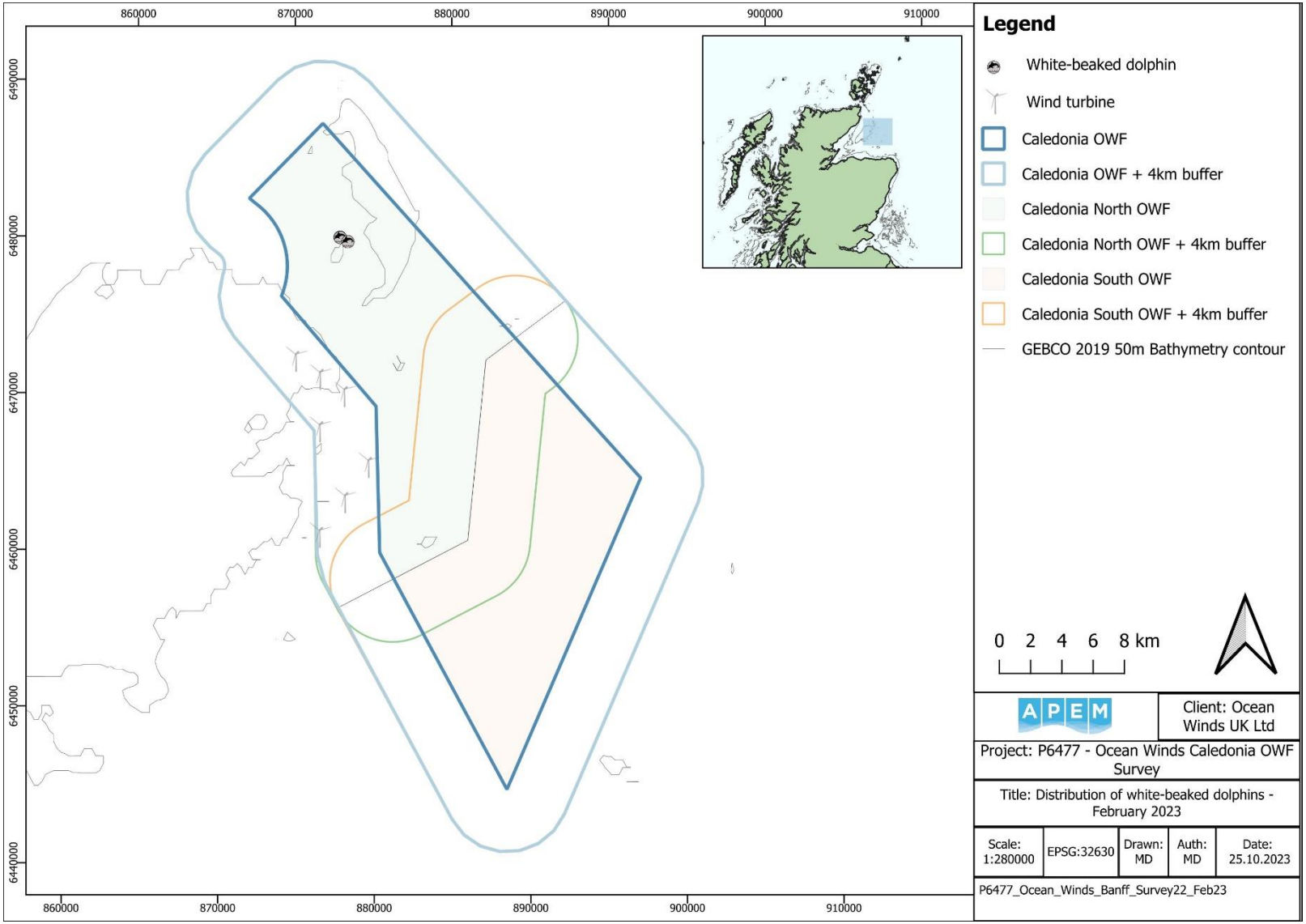



**Figure A4.385 Distribution of white-beaked dolphins recorded in the Survey Area in February 2023**

## Bottlenose dolphin

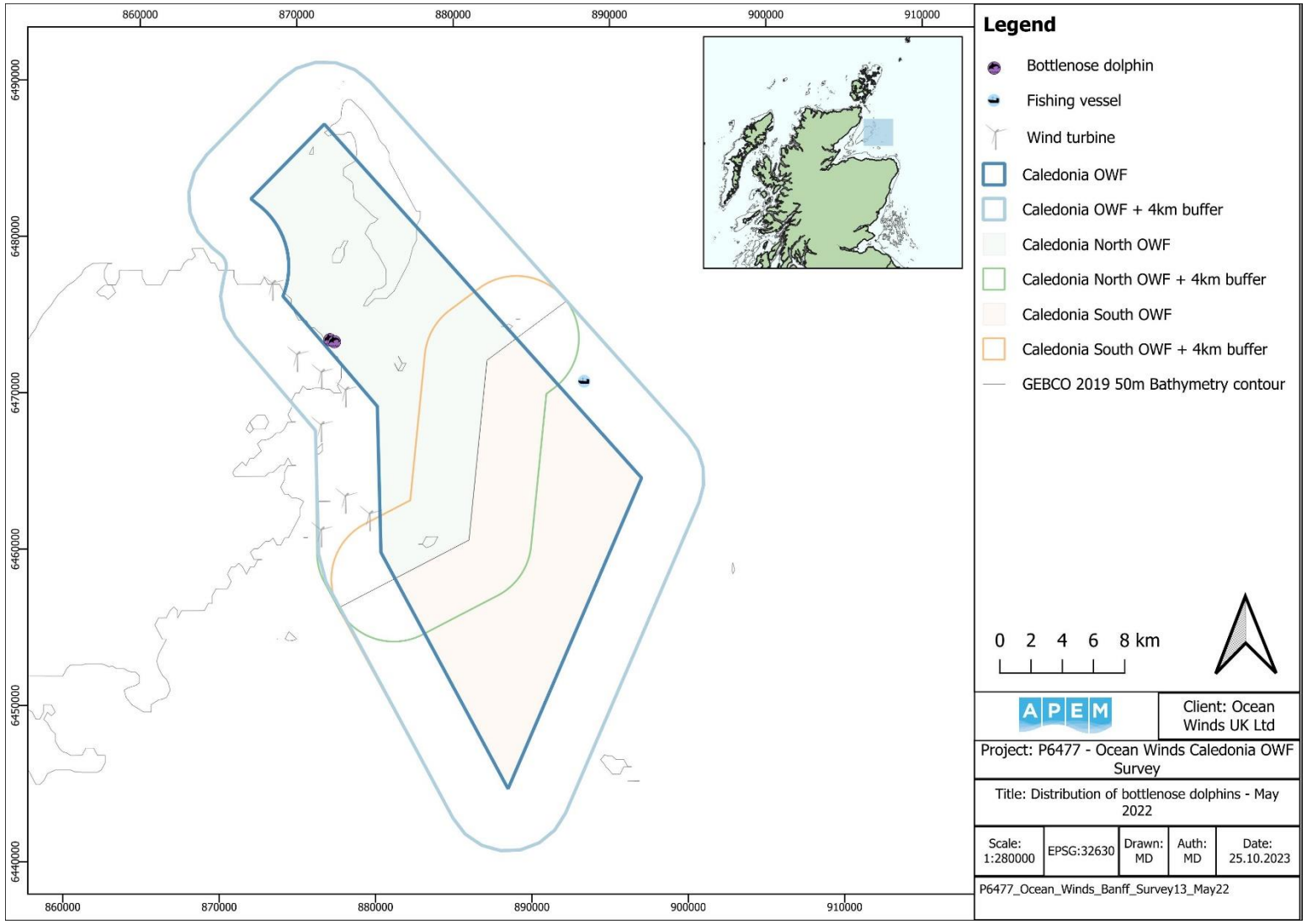



**Figure A4.386 Distribution of bottlenose dolphins recorded in the Survey Area in May 2022**

## Risso's dolphin

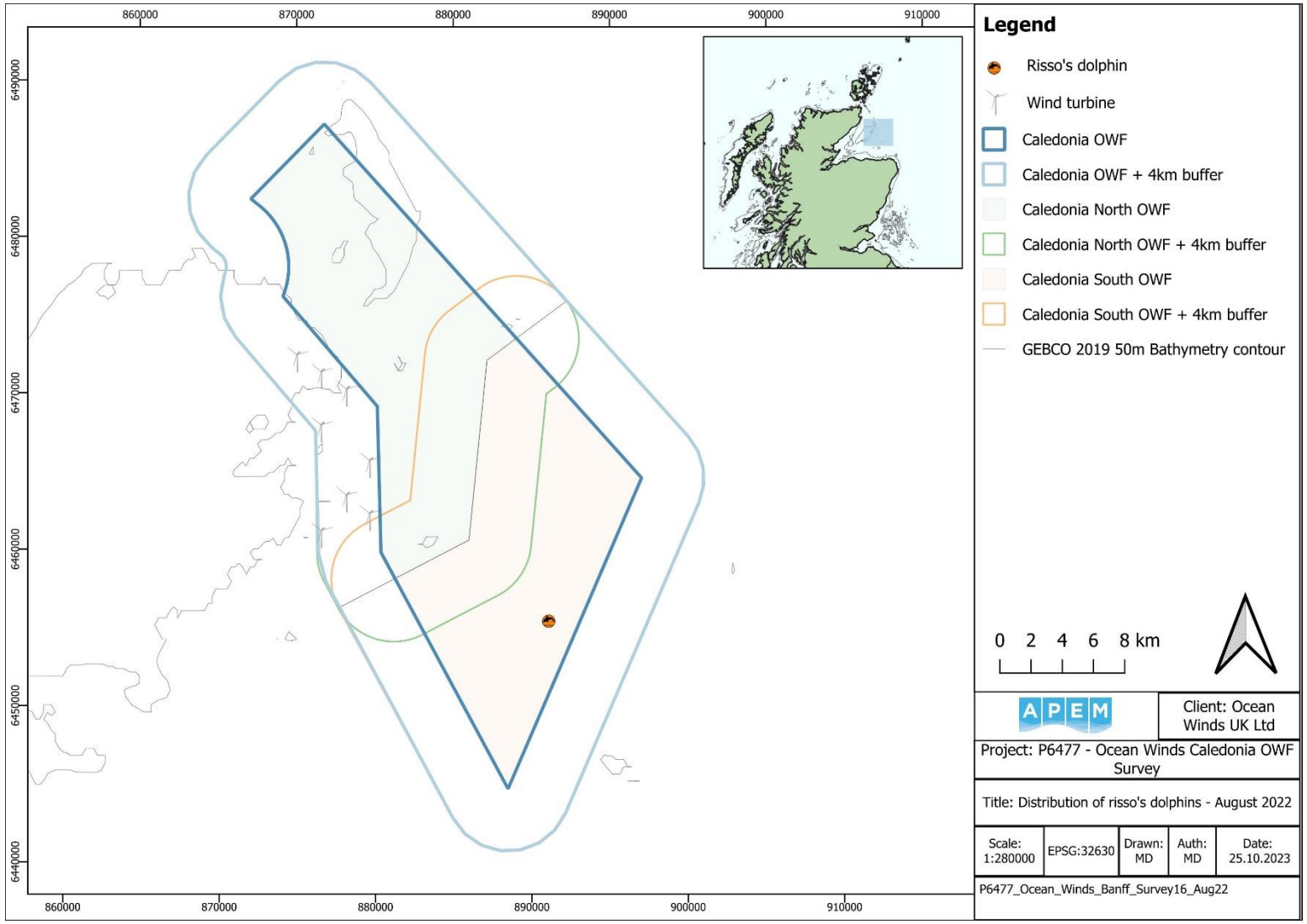



**Figure A4.387 Distribution of Risso's dolphins recorded in the Survey Area in August 2022**

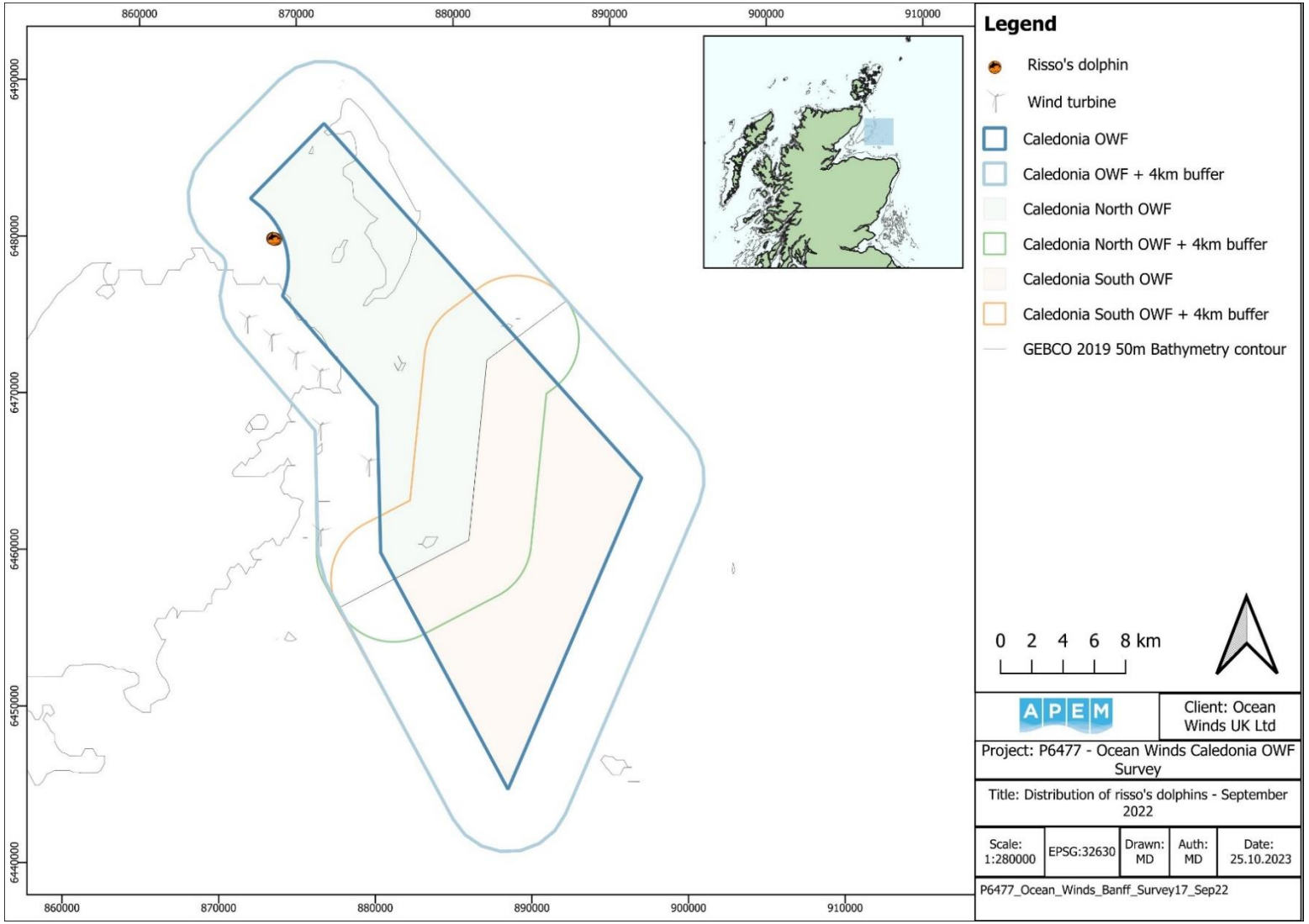



**Figure A4.388 Distribution of Risso's dolphins recorded in the Survey Area in September 2022**

### Unidentified dolphin species

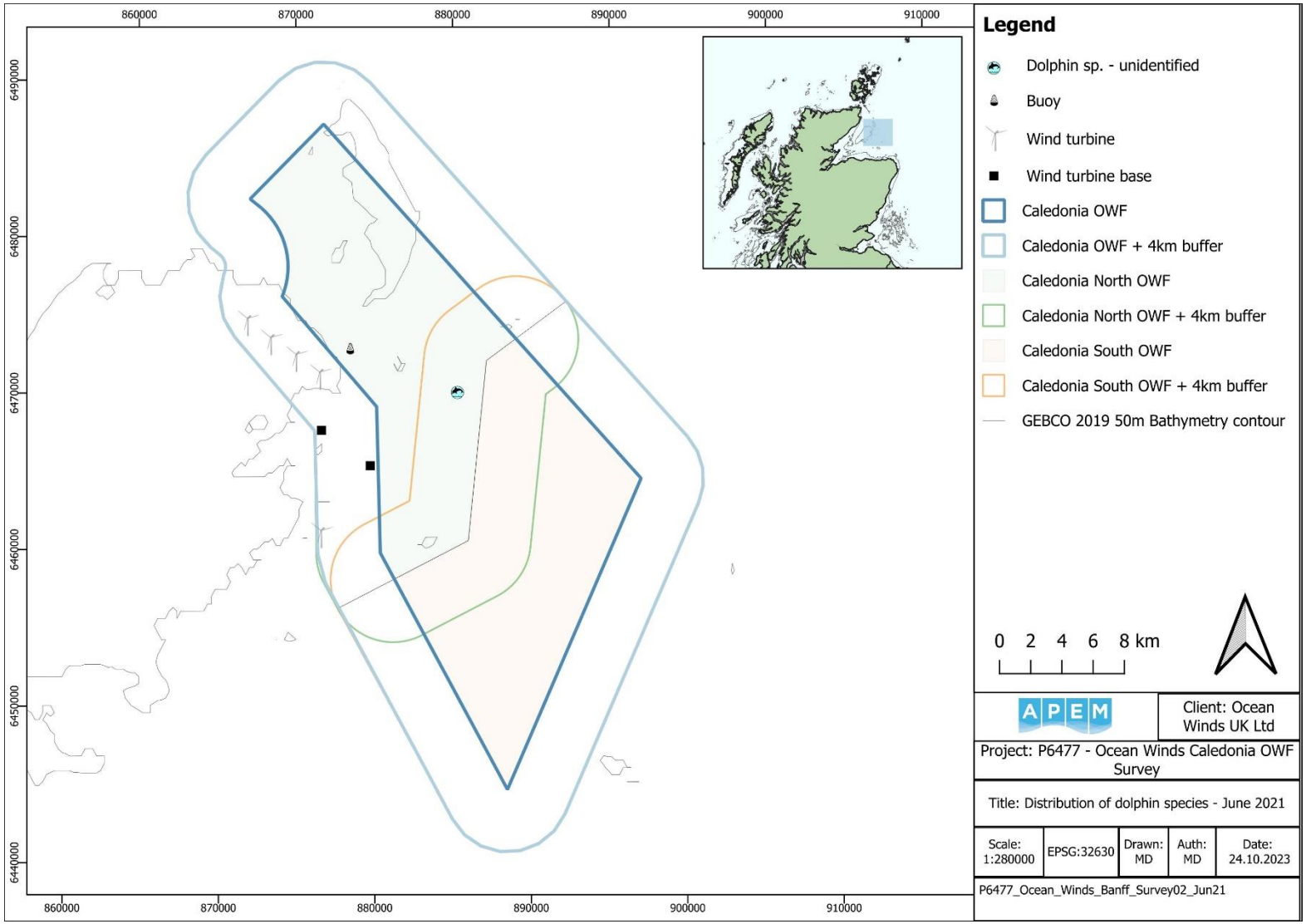



**Figure A4.389 Distribution of unidentified dolphin species recorded in the Survey Area in June 2021**

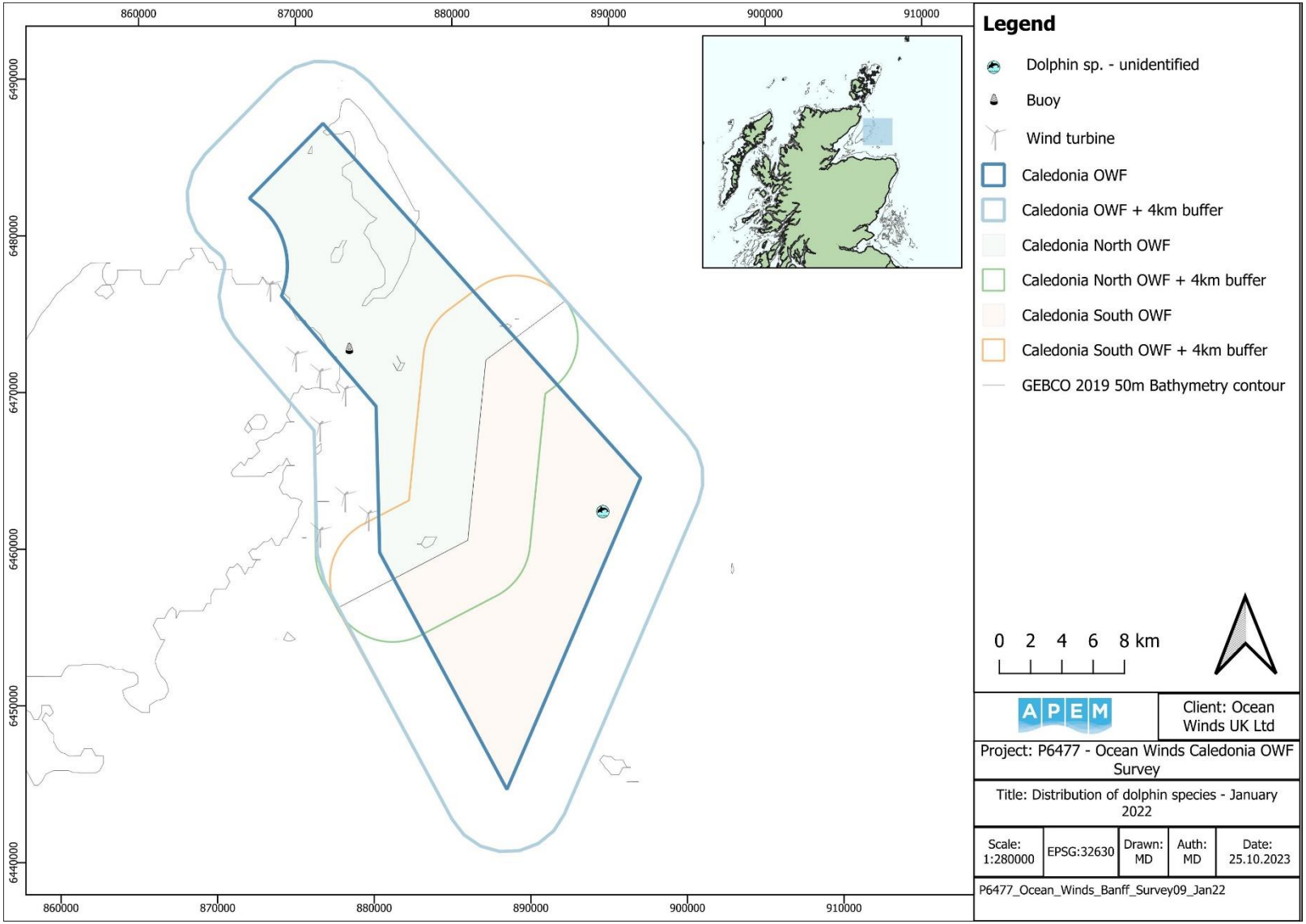



**Figure A4.390 Distribution of unidentified dolphin species recorded in the Survey Area in January 2022**

## Harbour porpoise

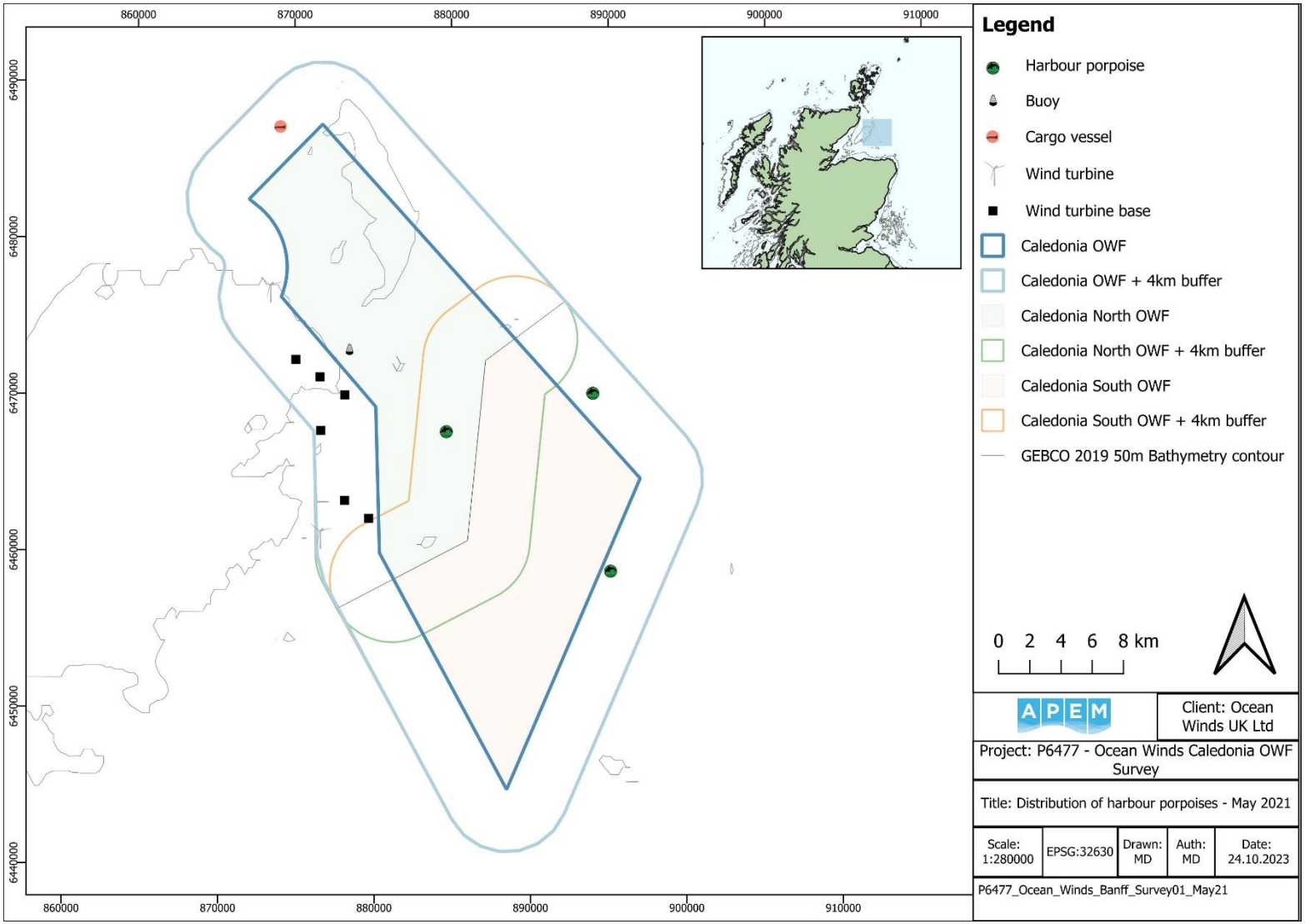



**Figure A4.391 Distribution of harbour porpoises recorded in the Survey Area in May 2021**

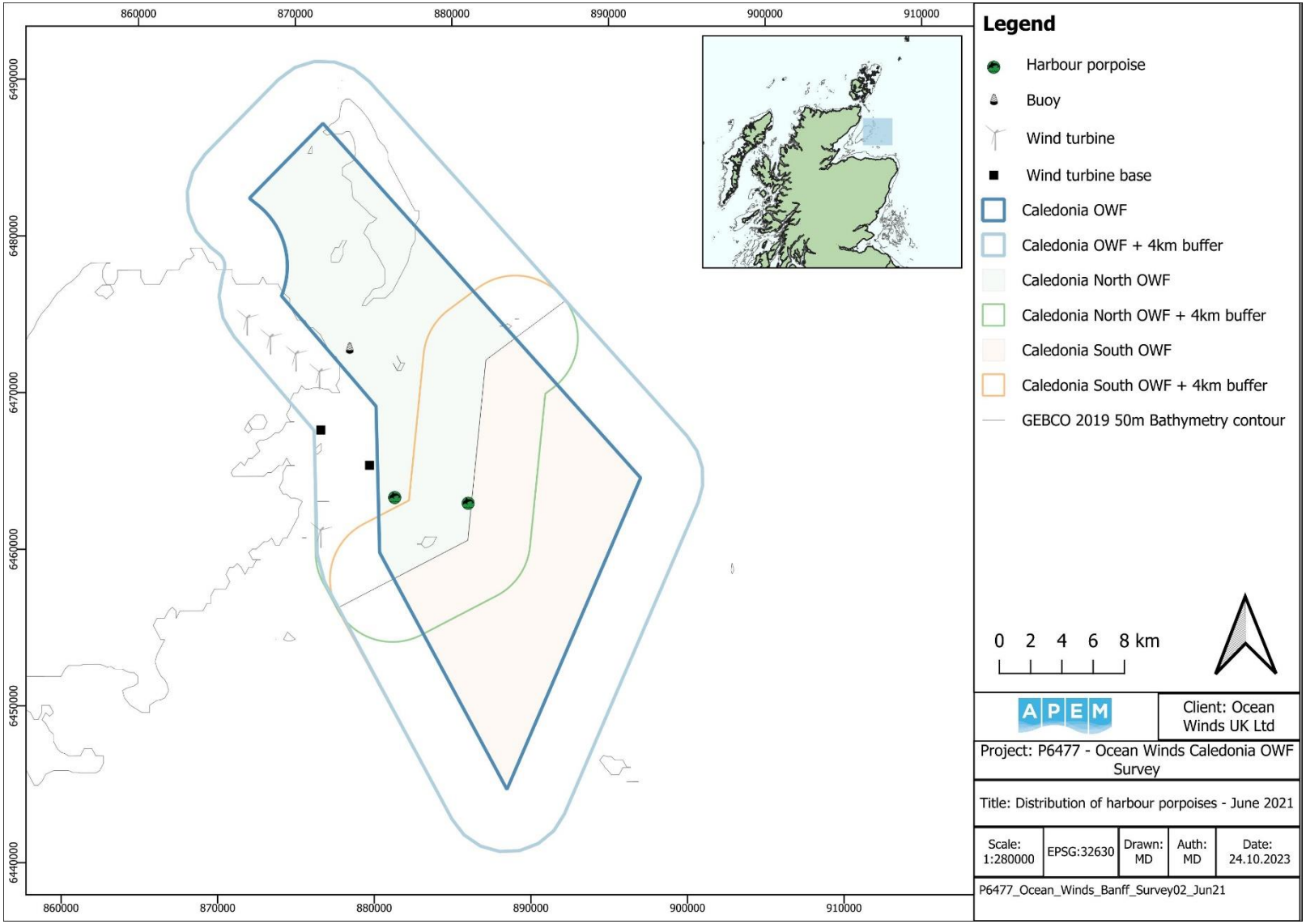



**Figure A4.392 Distribution of harbour porpoises recorded in the Survey Area in June 2021**

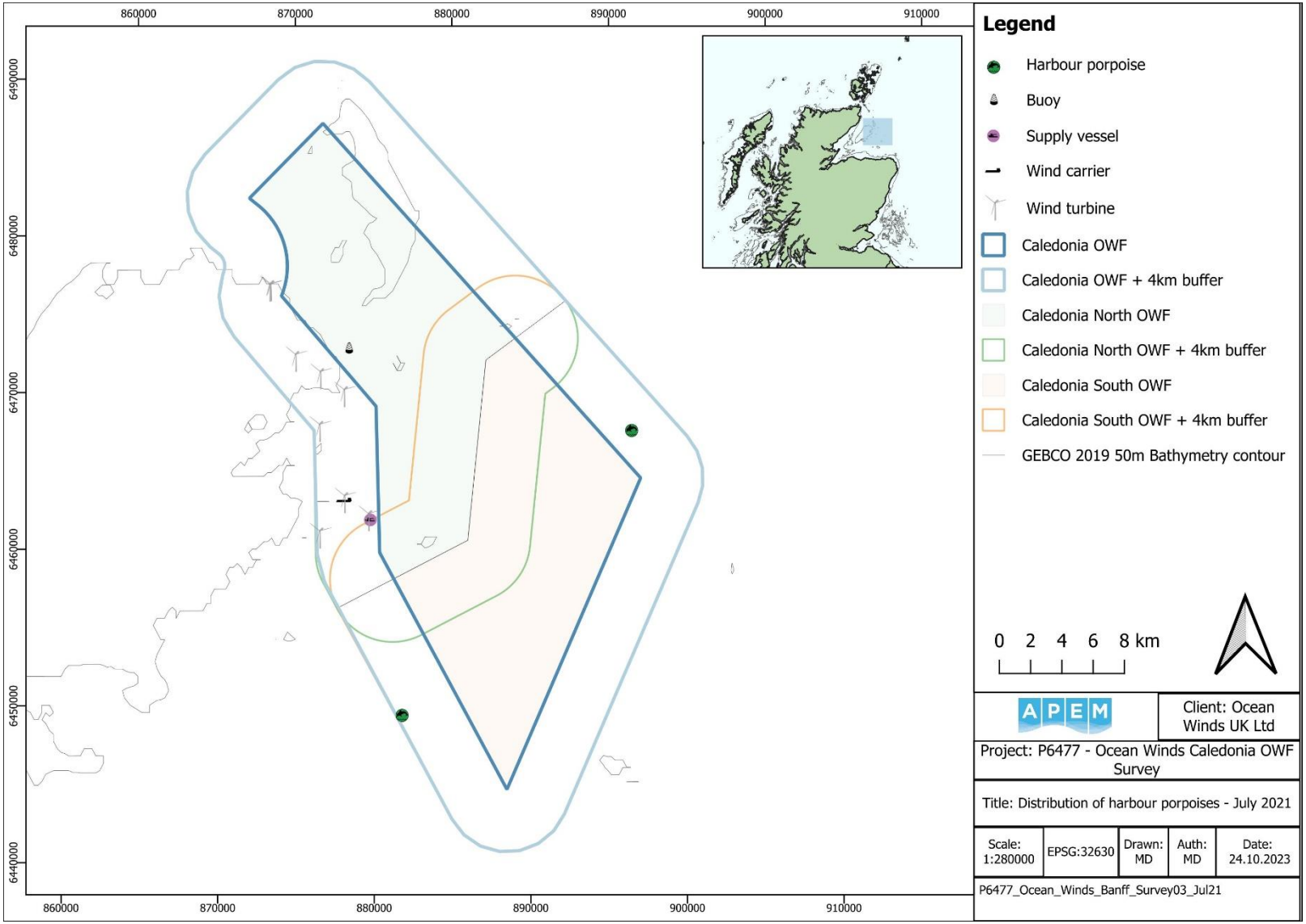



**Figure A4.393 Distribution of harbour porpoises recorded in the Survey Area in July 2021**

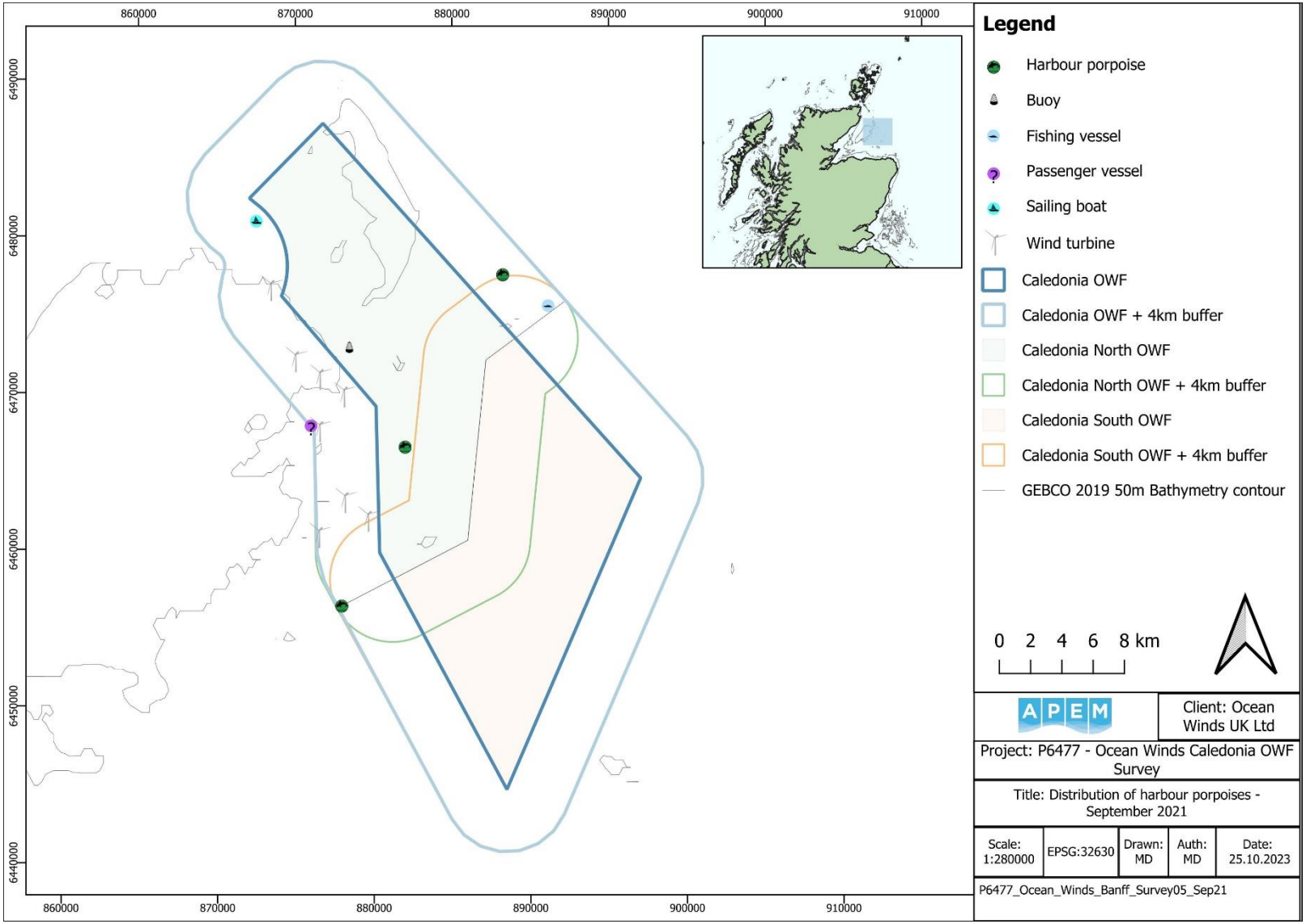



**Figure A4.394 Distribution of harbour porpoises recorded in the Survey Area in September 2021**

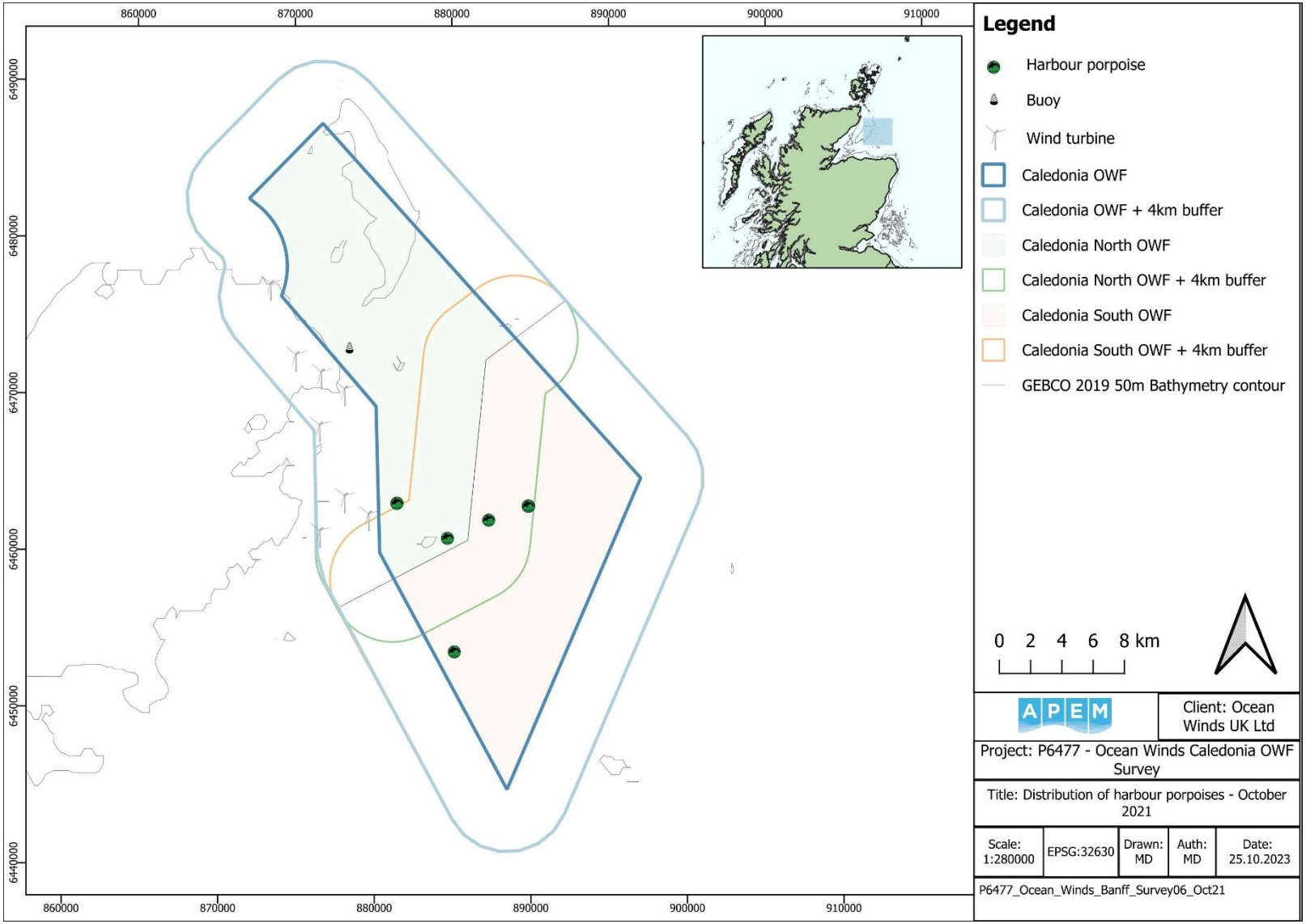



**Figure A4.395 Distribution of harbour porpoises recorded in the Survey Area in October 2021**

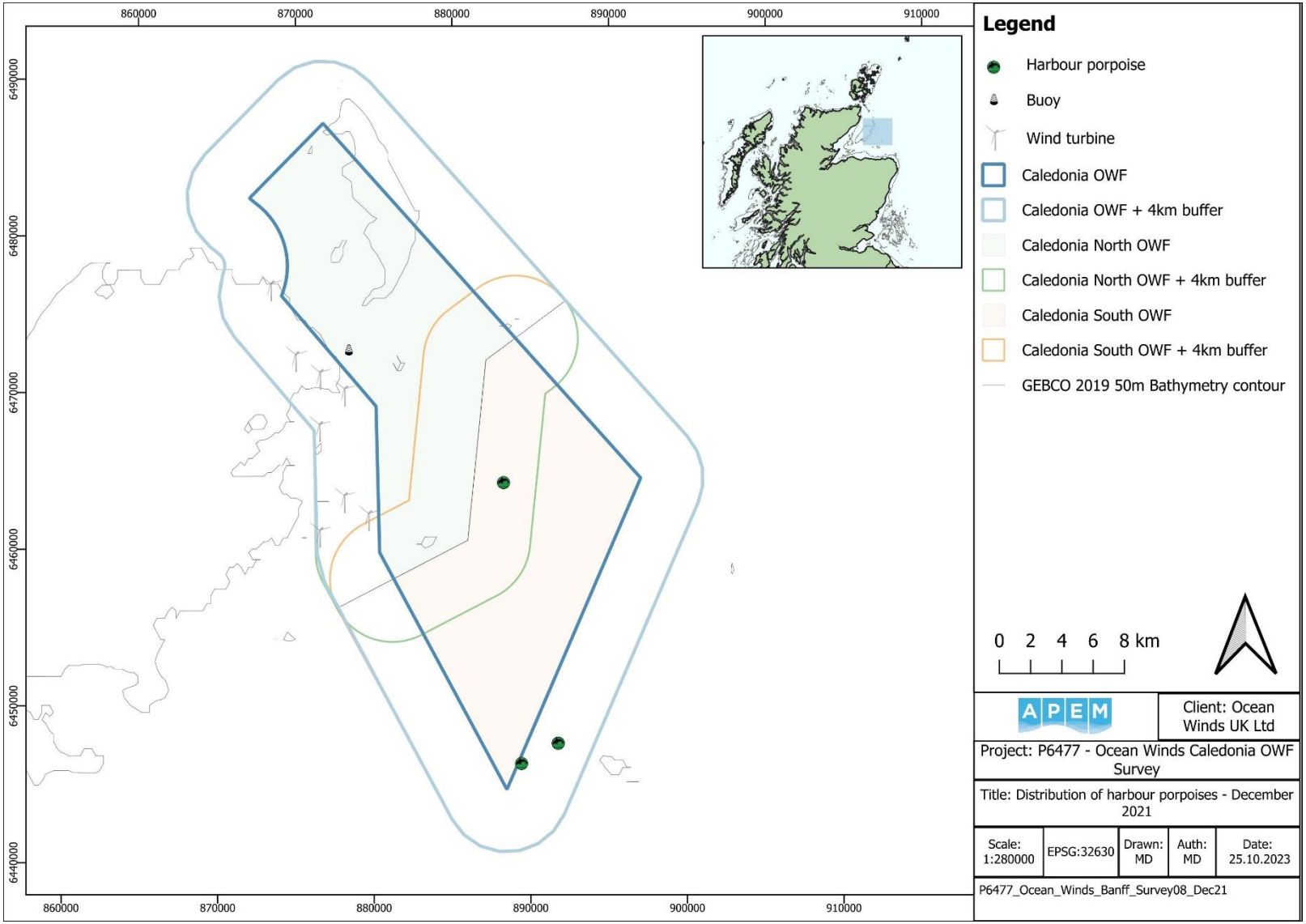



**Figure A4.396 Distribution of harbour porpoises recorded in the Survey Area in December 2021**

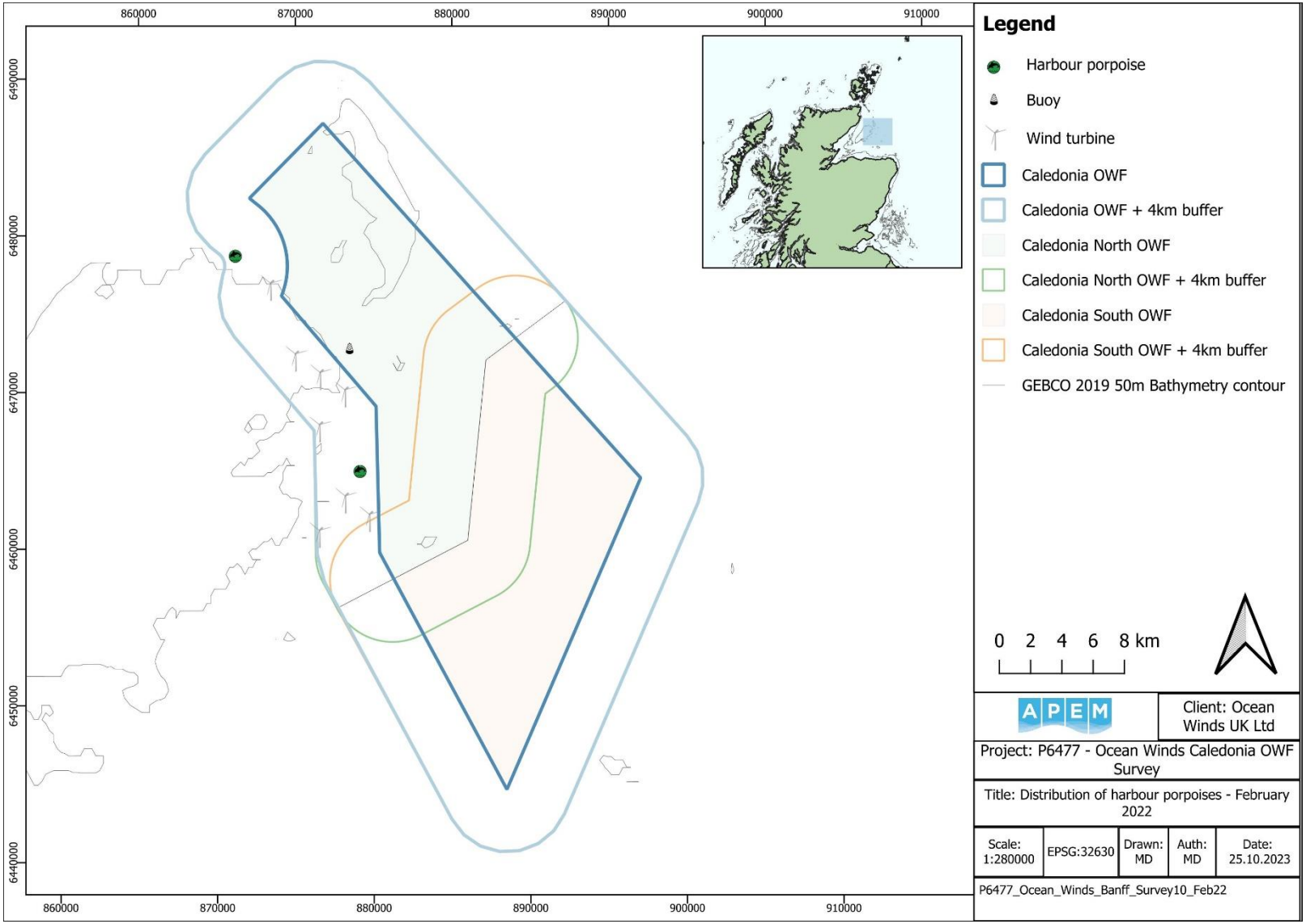



**Figure A4.397 Distribution of harbour porpoises recorded in the Survey Area in February 2022**

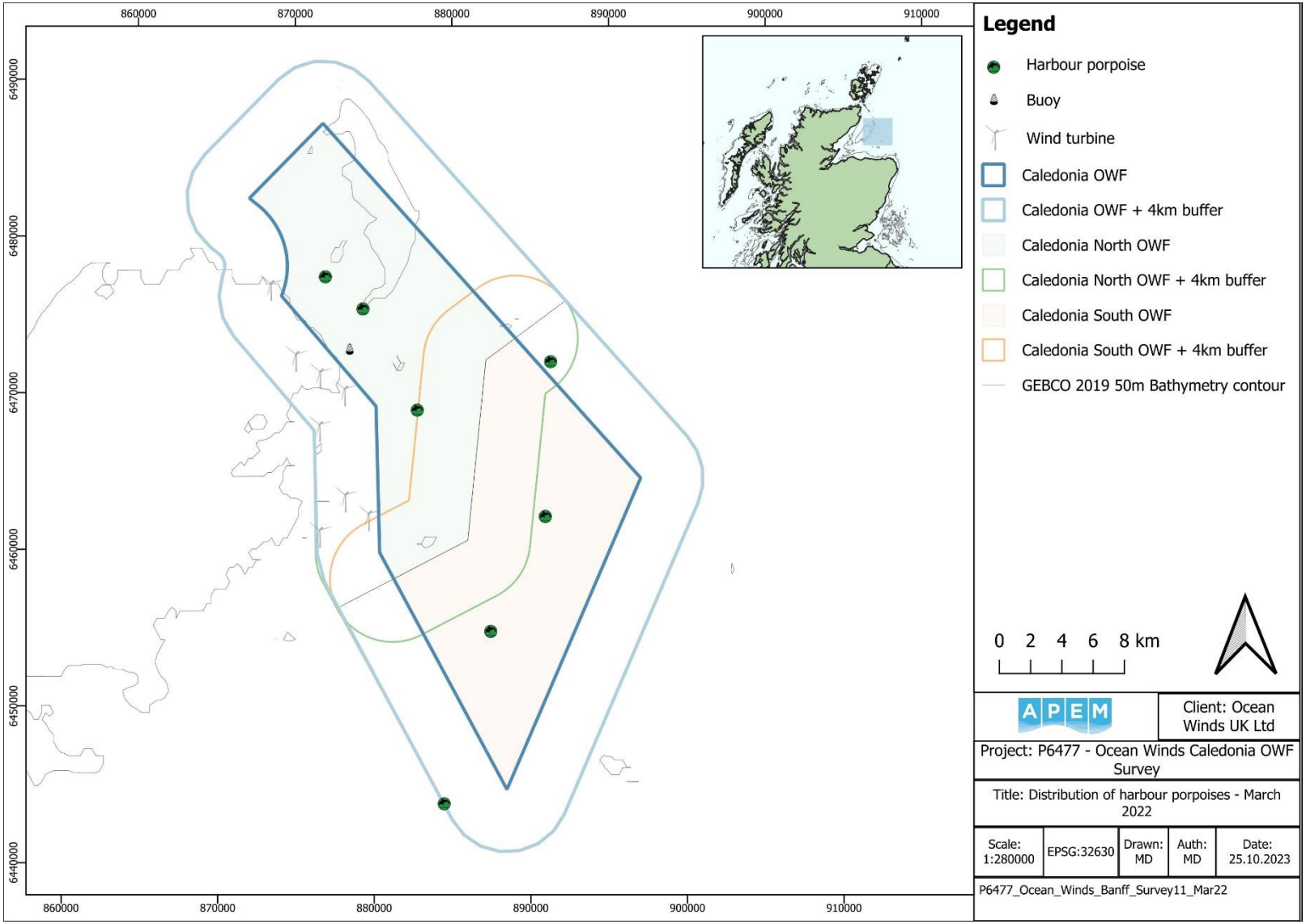



**Figure A4.398 Distribution of harbour porpoises recorded in the Survey Area in March 2022**

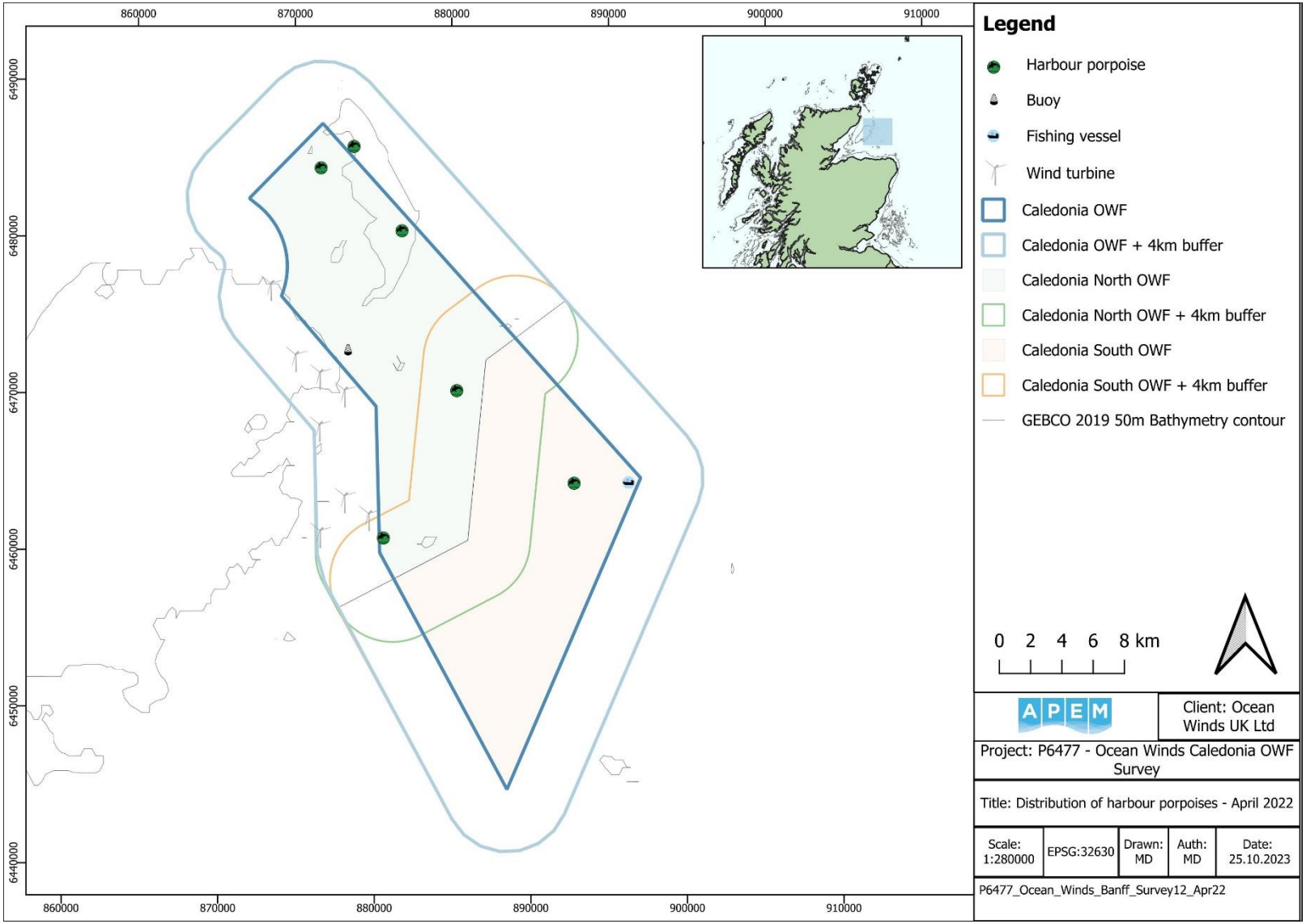



**Figure A4.399 Distribution of harbour porpoises recorded in the Survey Area in April 2022**

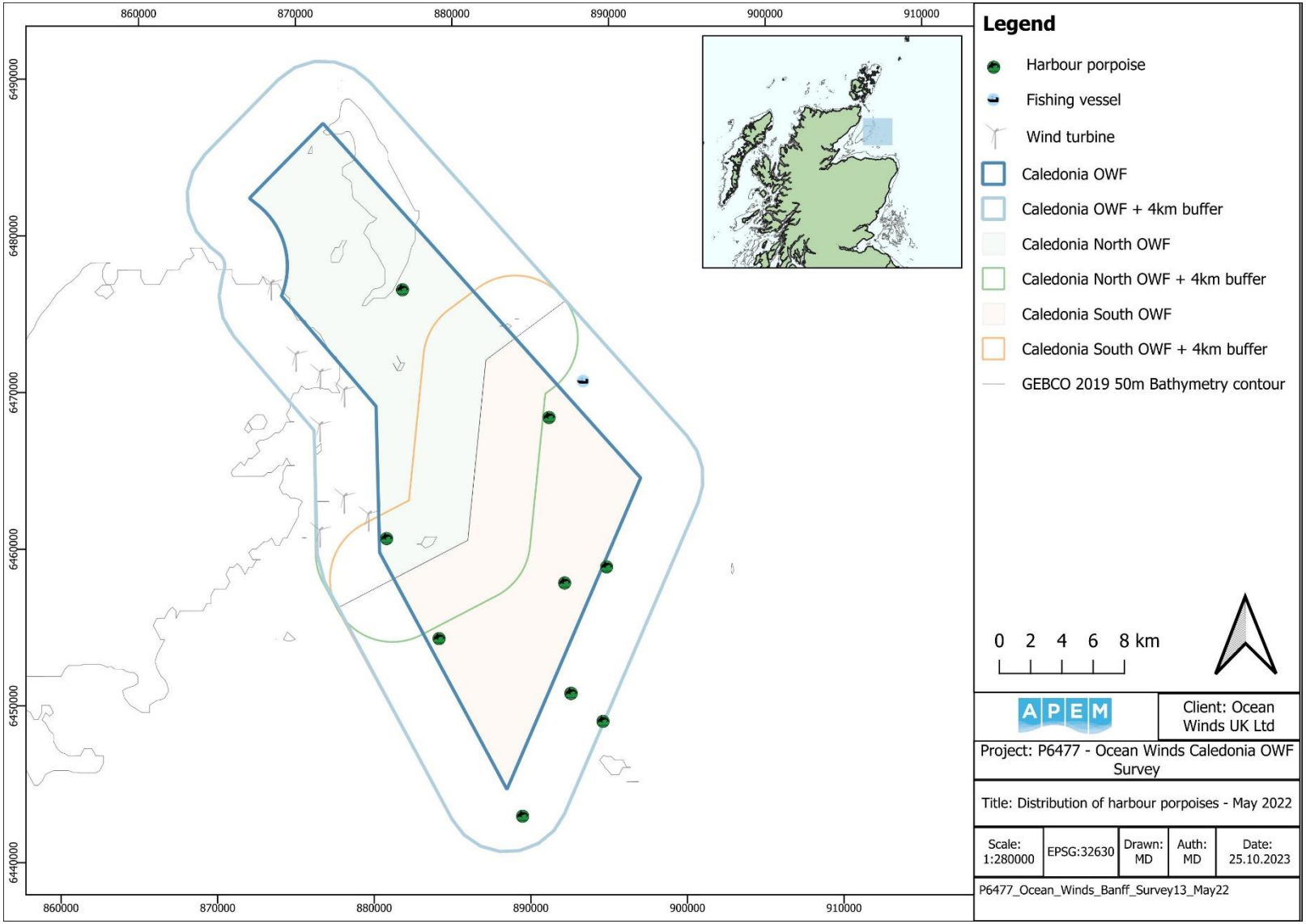



**Figure A4.400 Distribution of harbour porpoises recorded in the Survey Area in May 2022**

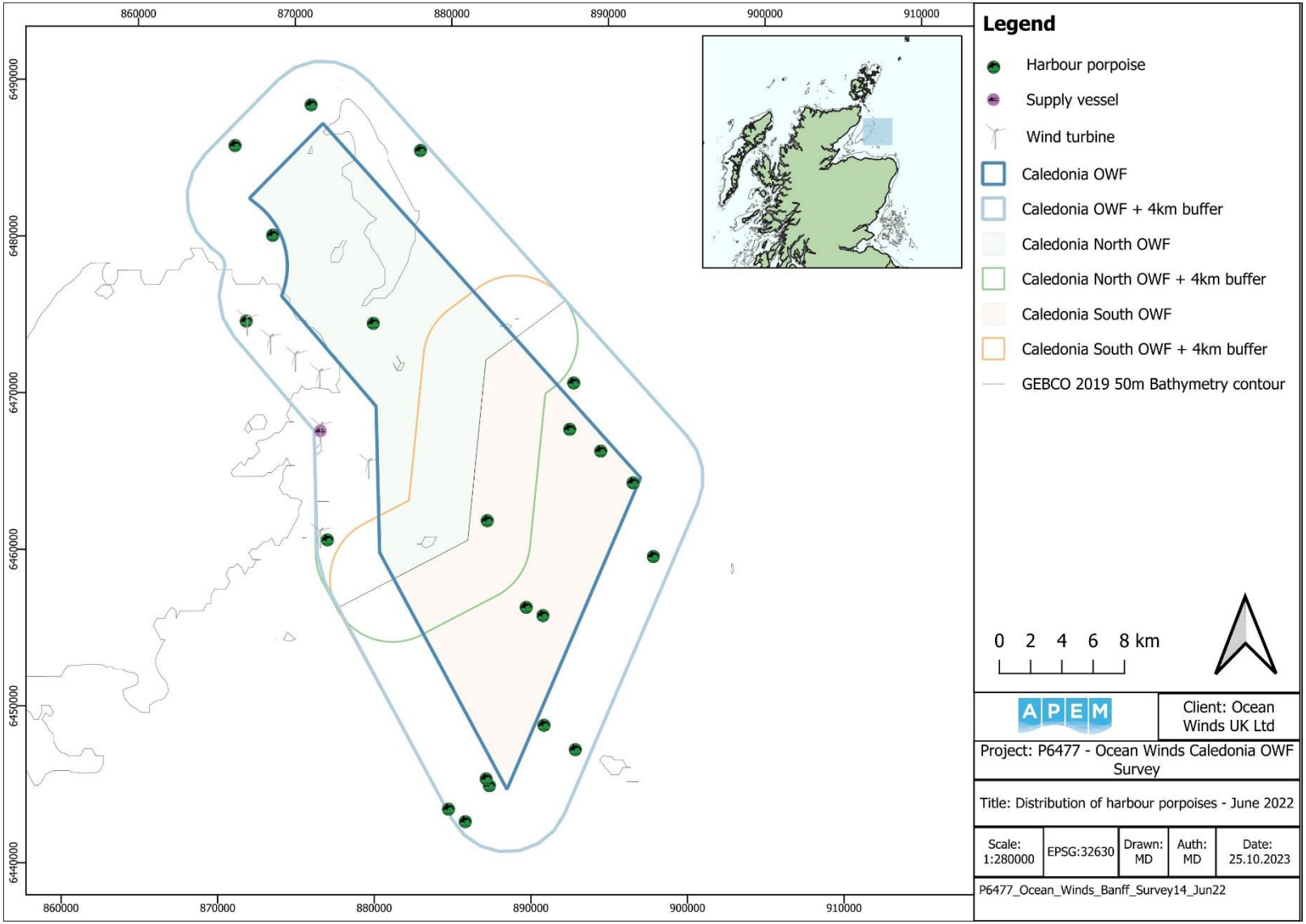



**Figure A4.401 Distribution of harbour porpoises recorded in the Survey Area in June 2022**

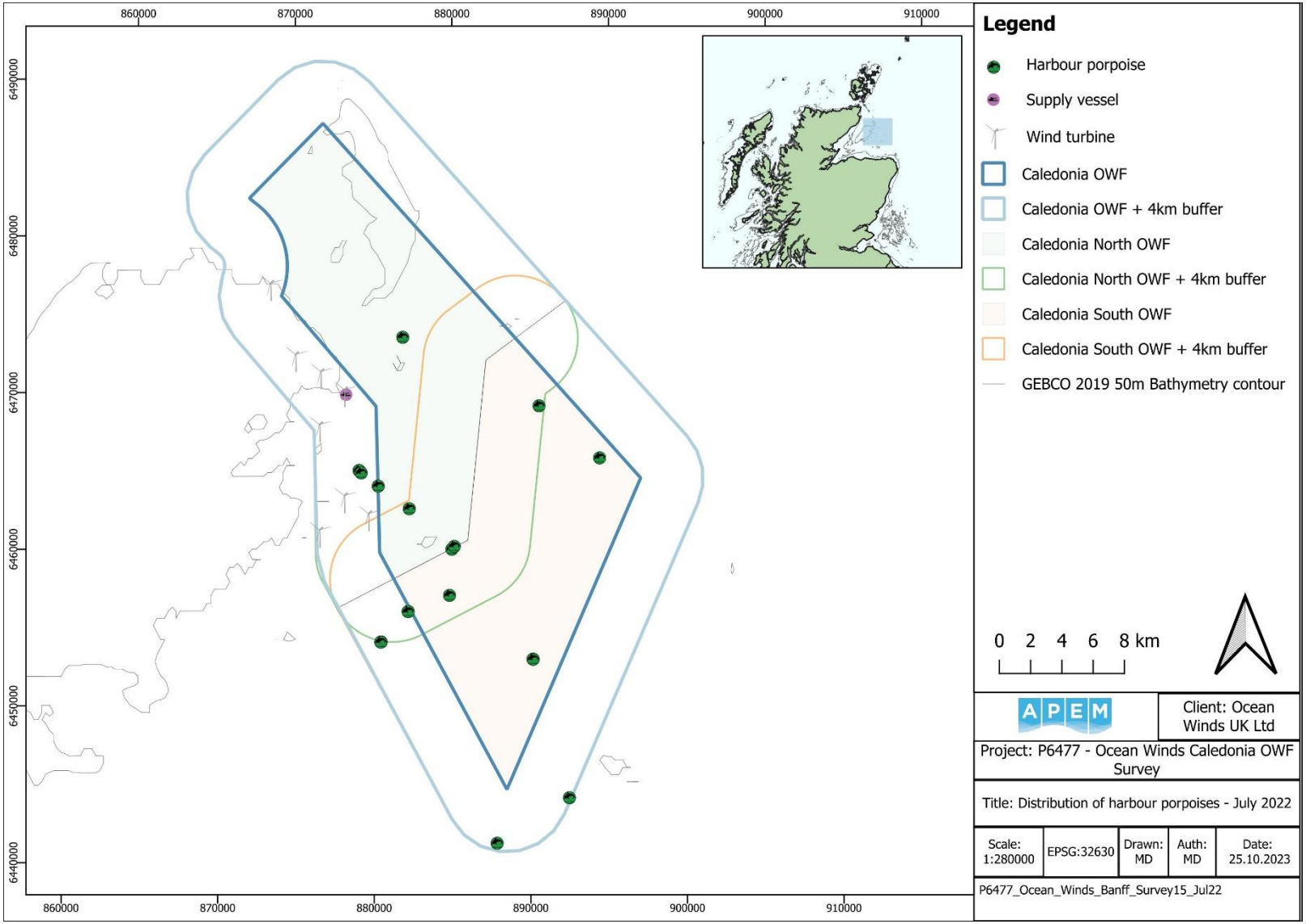



**Figure A4.402 Distribution of harbour porpoises recorded in the Survey Area in July 2022**

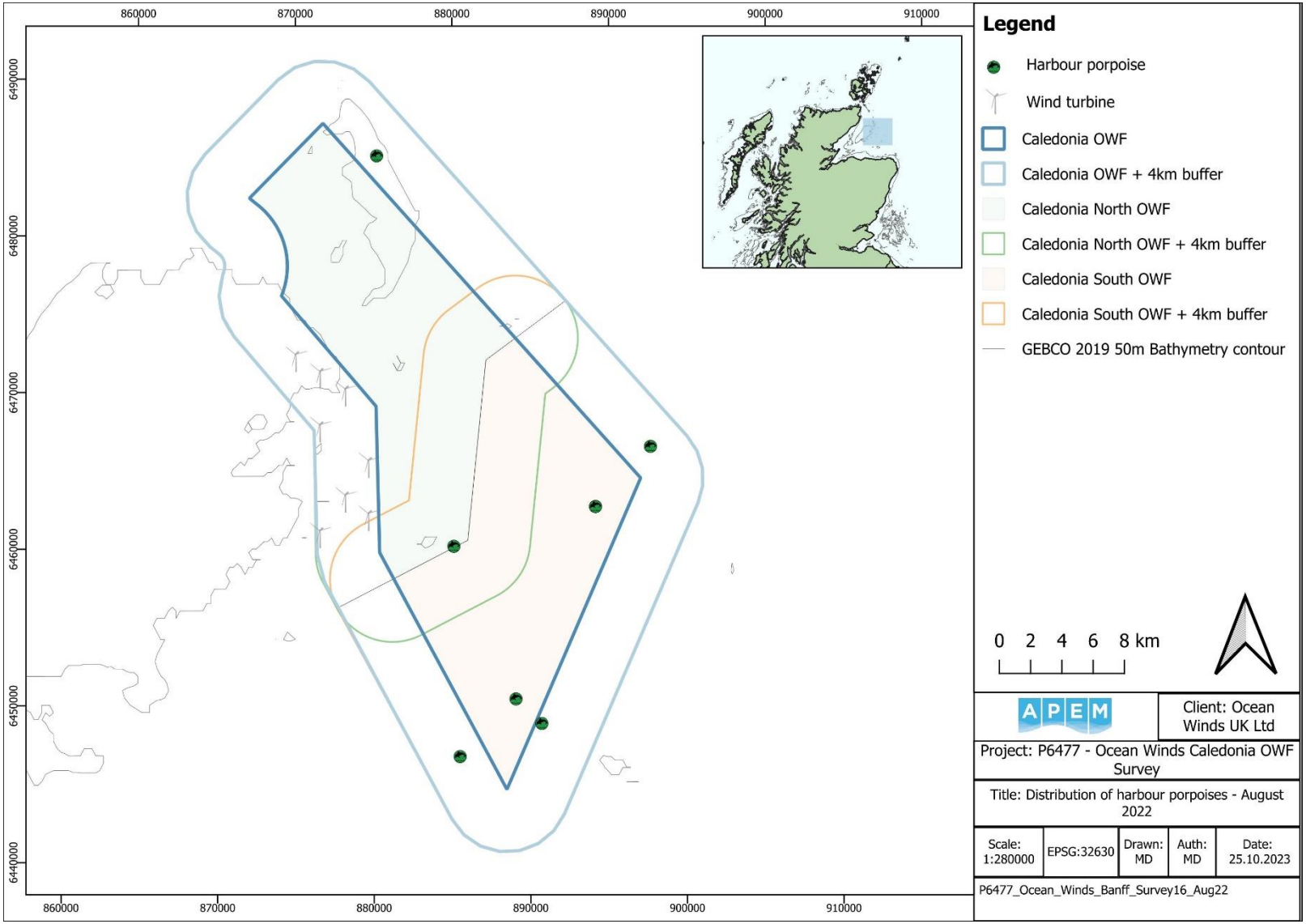



**Figure A4.403 Distribution of harbour porpoises recorded in the Survey Area in August 2022**

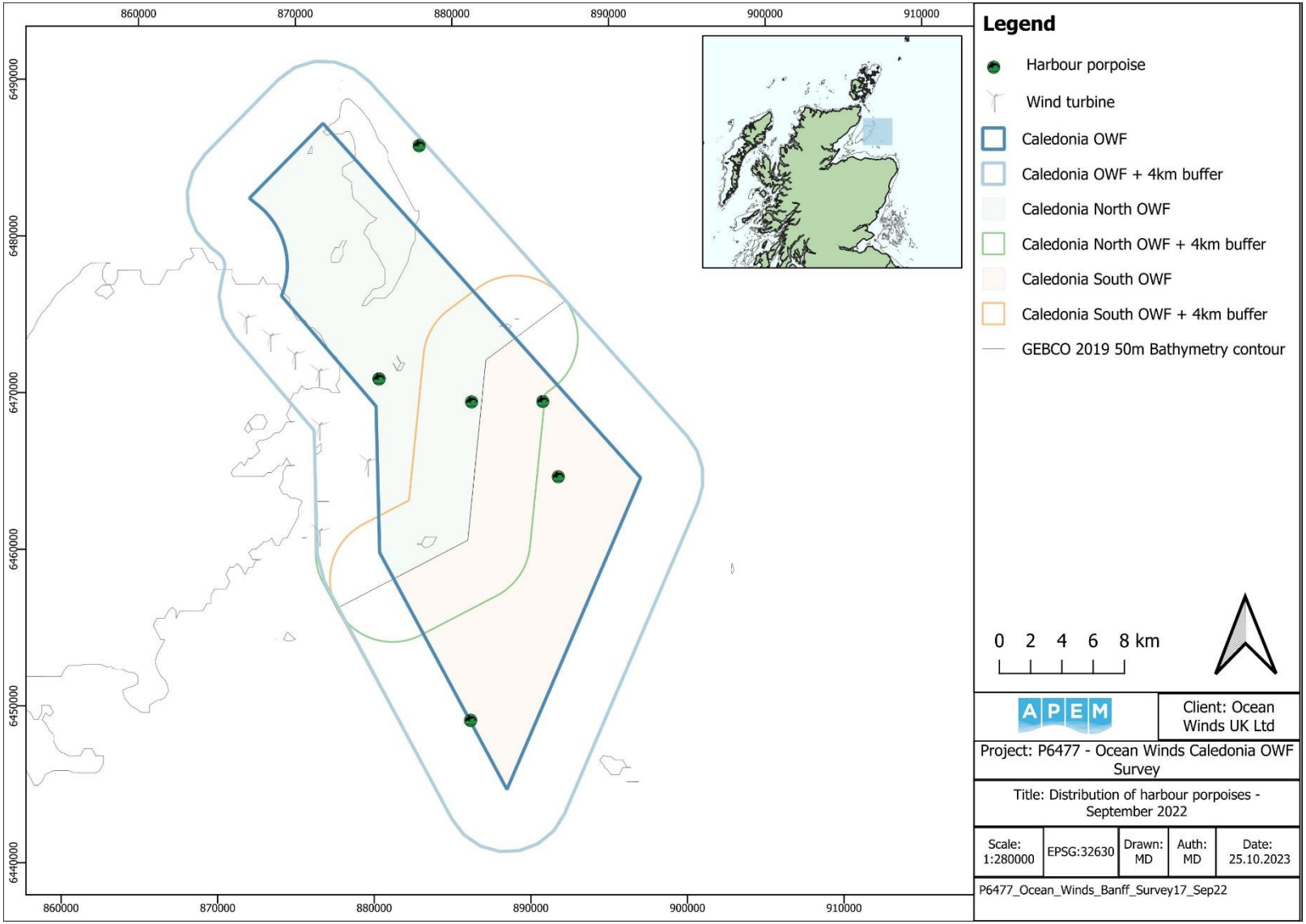



**Figure A4.404 Distribution of harbour porpoises recorded in the Survey Area in September 2022**

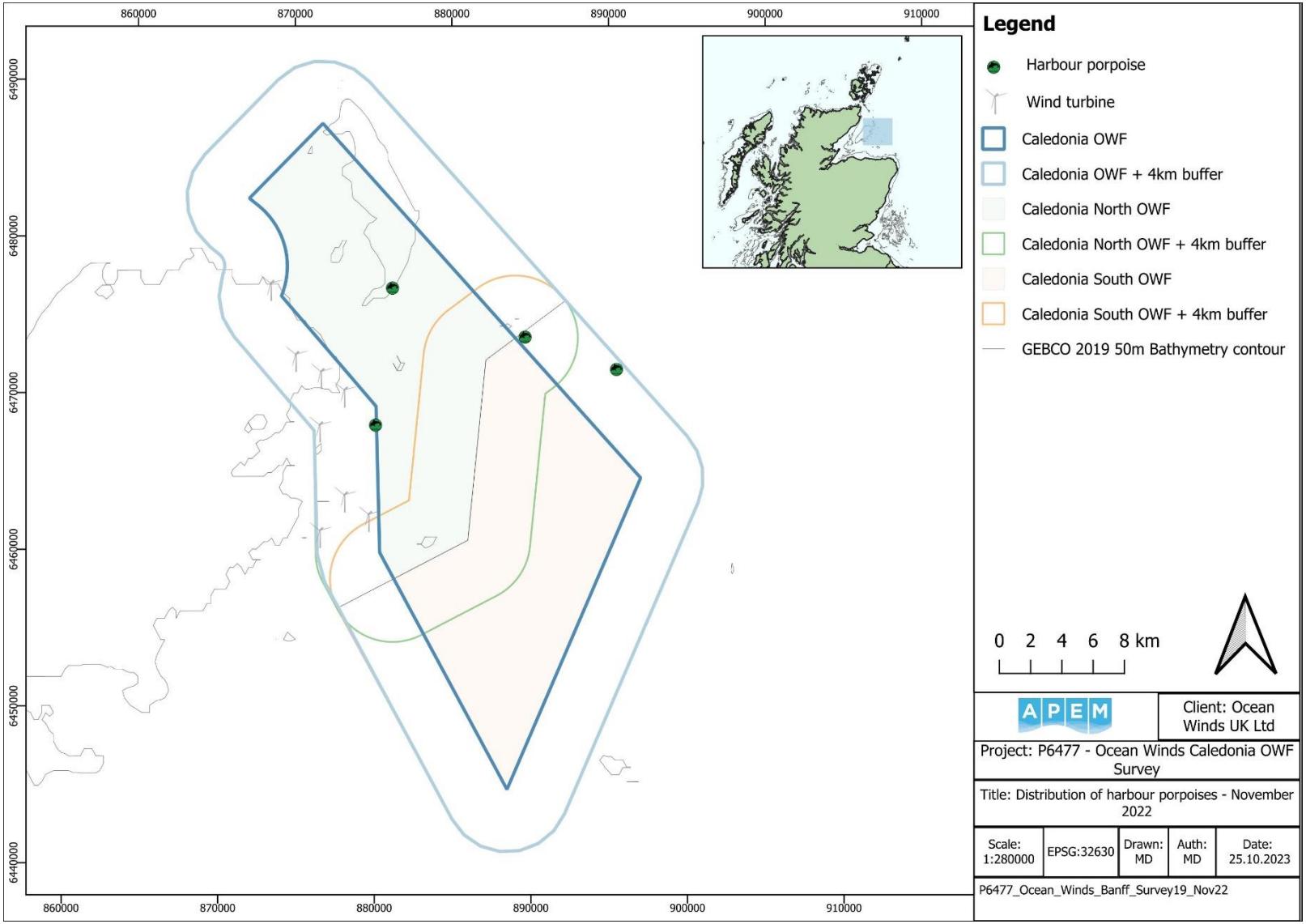



**Figure A4.405 Distribution of harbour porpoises recorded in the Survey Area in November 2022**

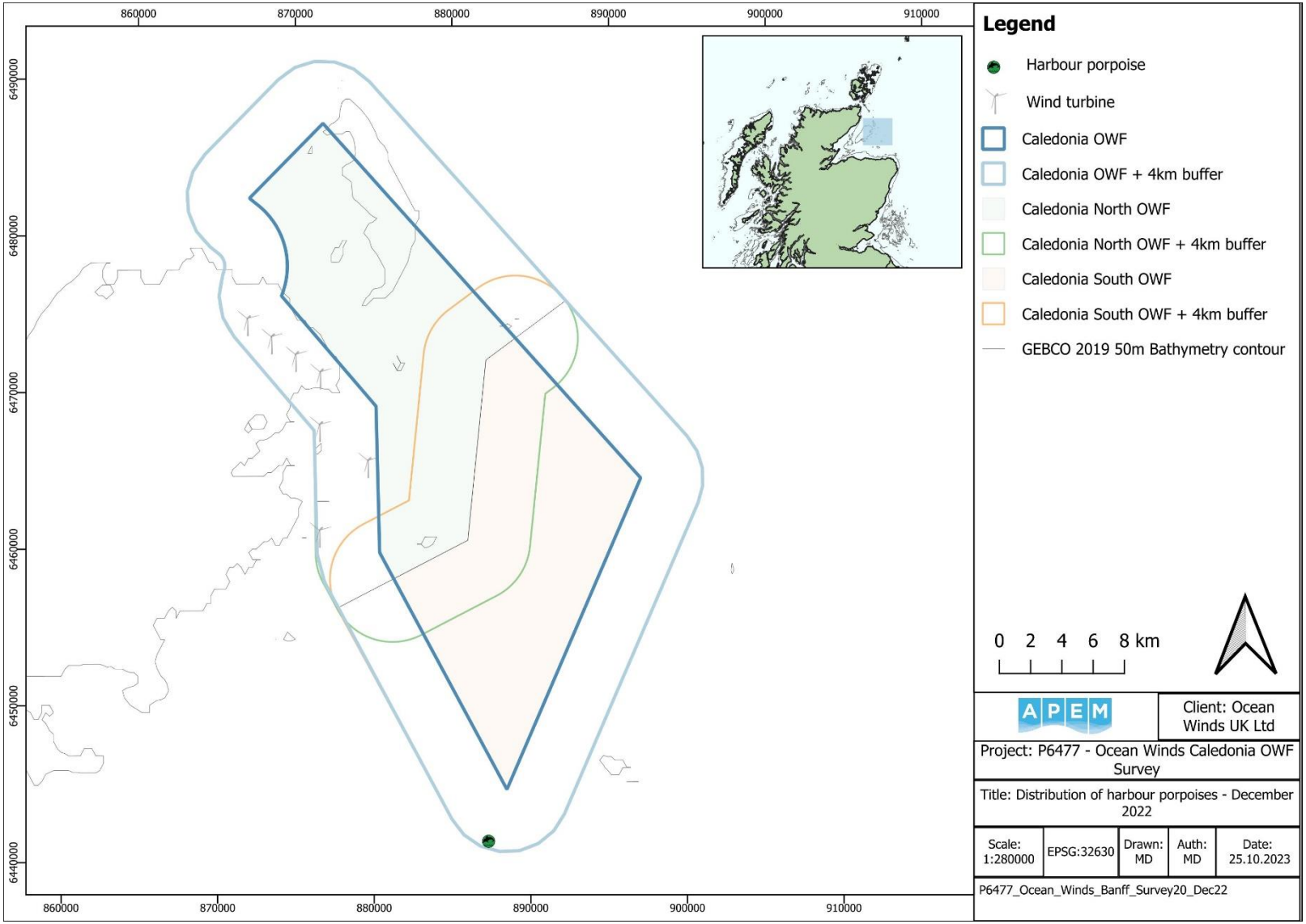



**Figure A4.406 Distribution of harbour porpoises recorded in the Survey Area in December 2022**

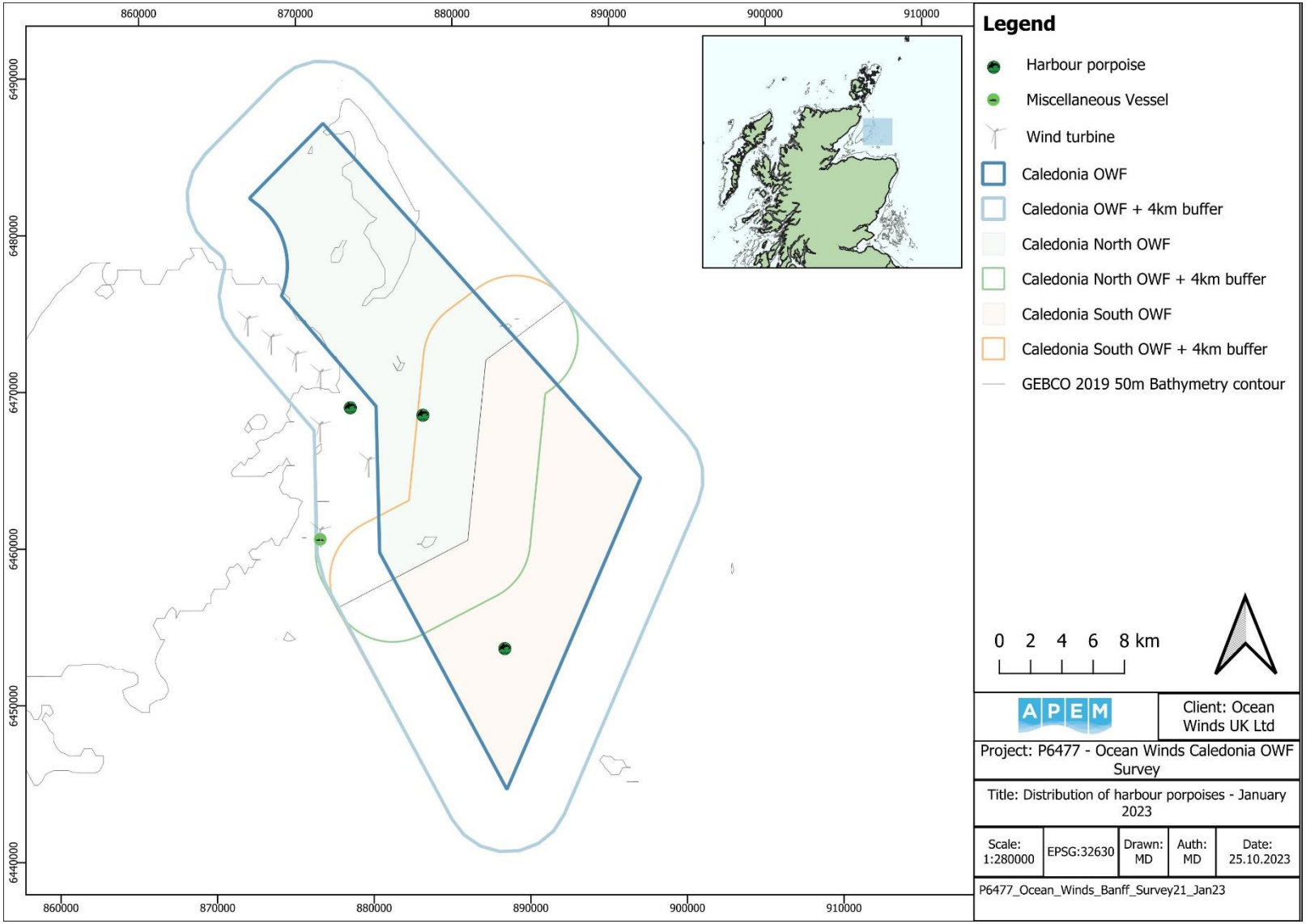



**Figure A4.407 Distribution of harbour porpoises recorded in the Survey Area in January 2023**

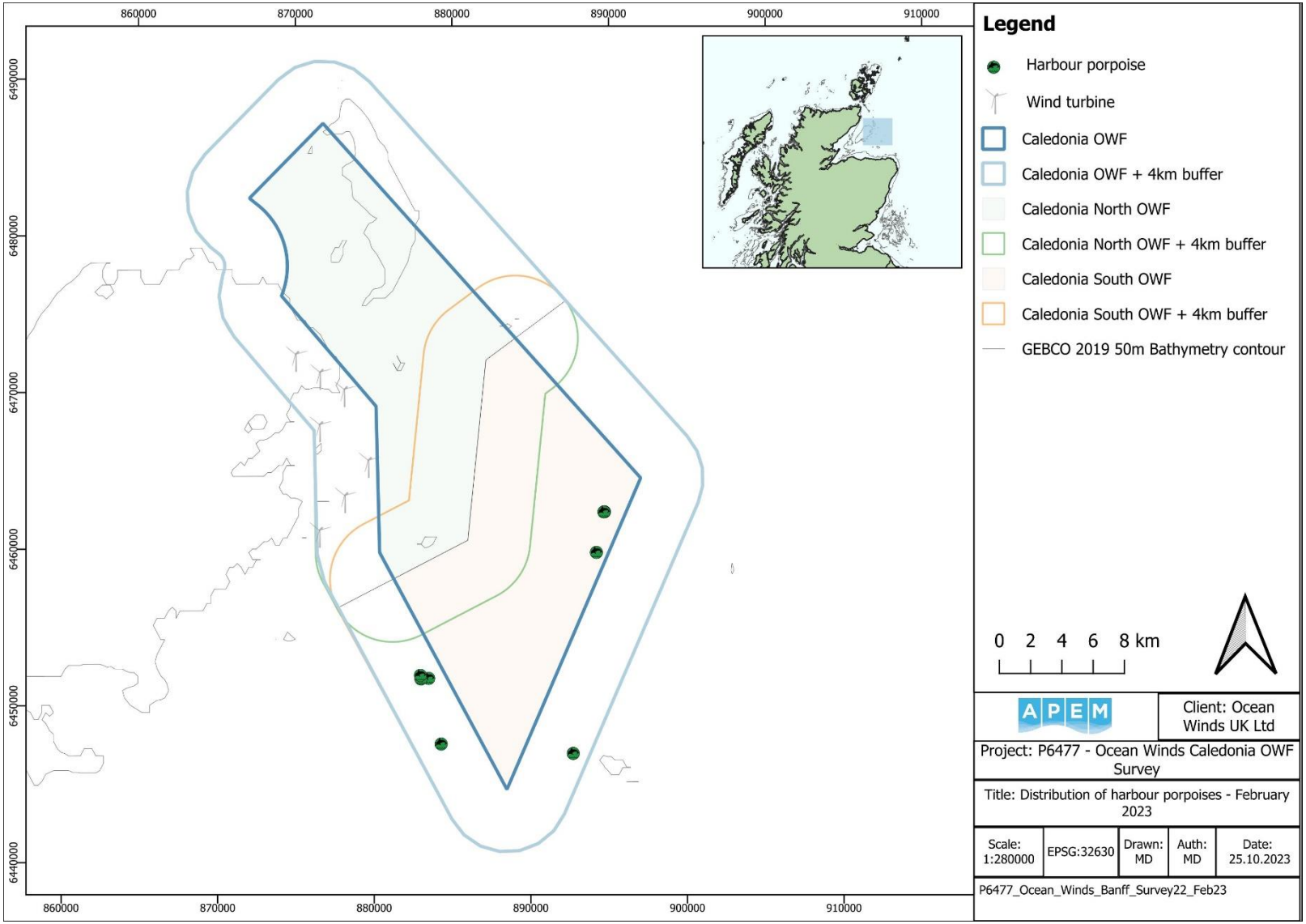



**Figure A4.408 Distribution of harbour porpoises recorded in the Survey Area in February 2023**

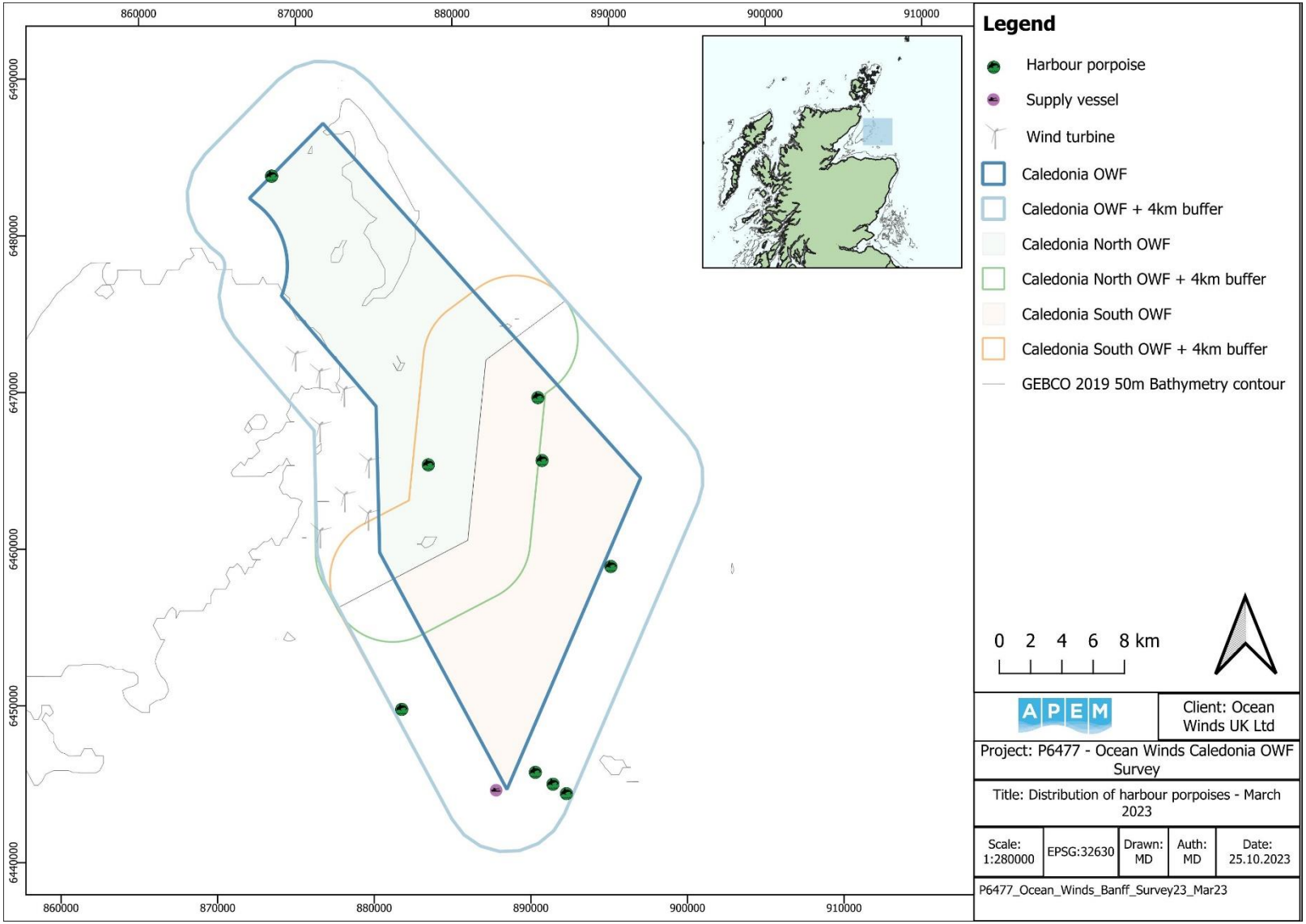



**Figure A4.409 Distribution of harbour porpoises recorded in the Survey Area in March 2023**

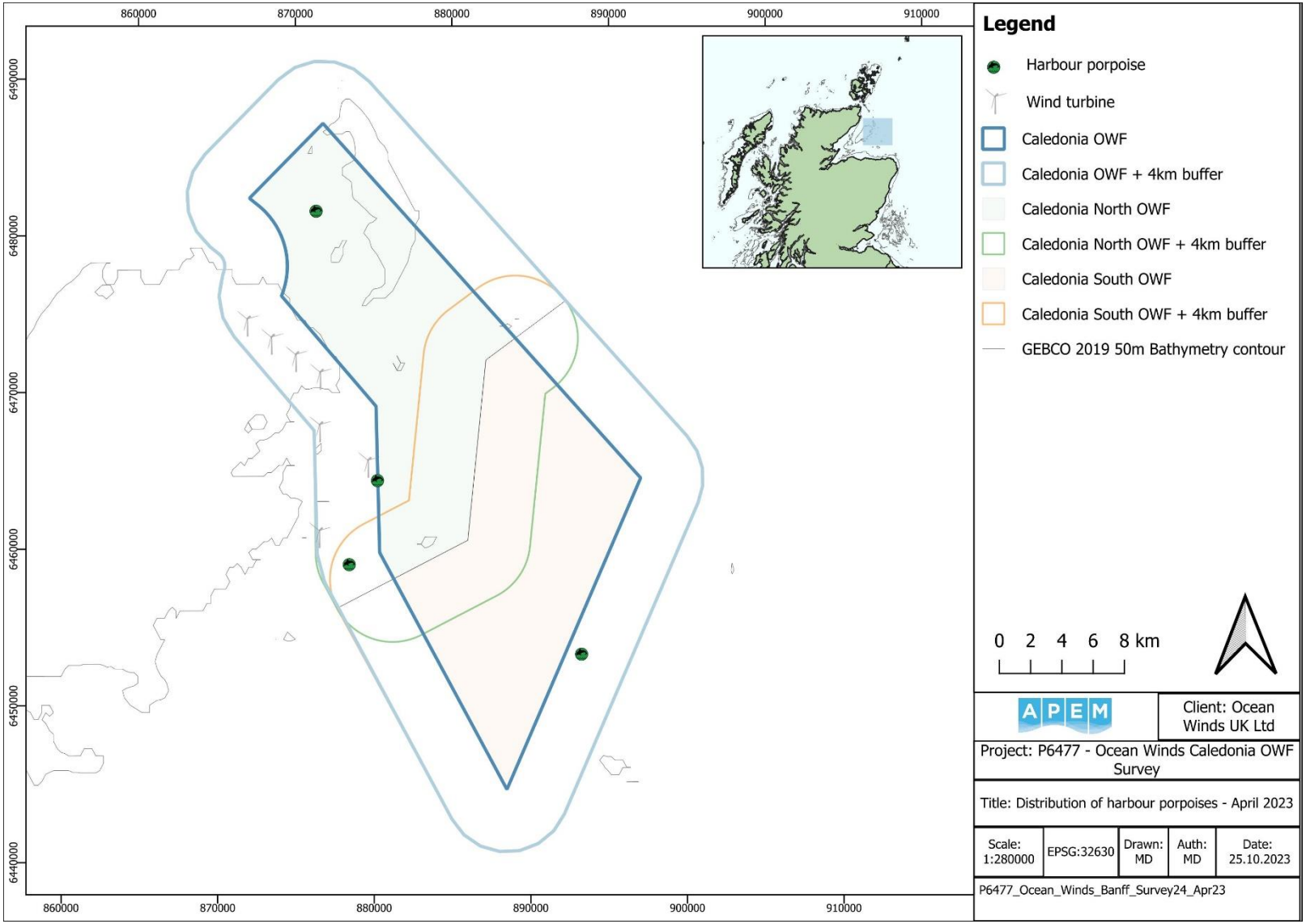



**Figure A4.410 Distribution of harbour porpoises recorded in the Survey Area in April 2023**

## Unidentified dolphin and / or porpoise species

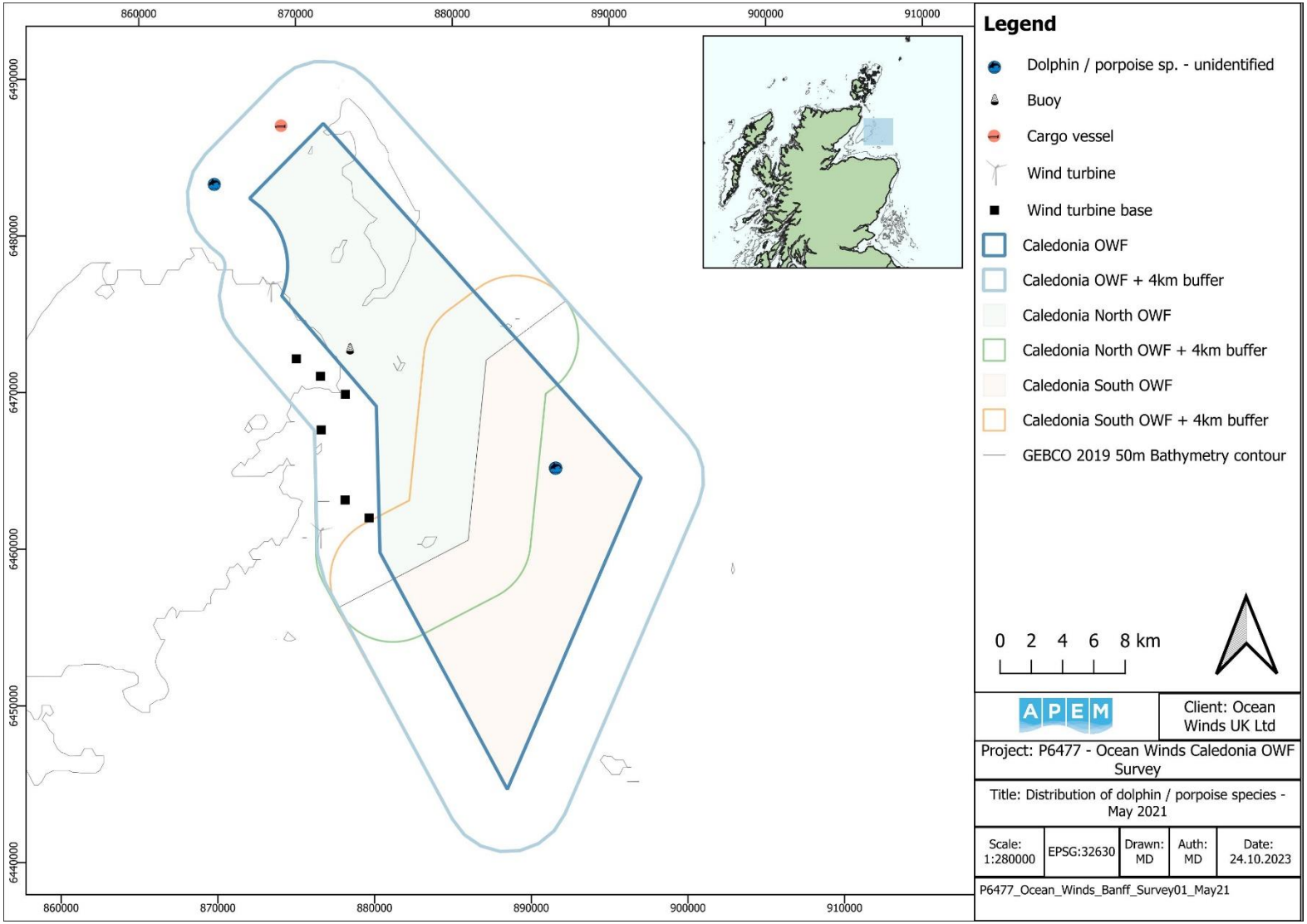



**Figure A4.411 Distribution of unidentified dolphin / porpoise species recorded in the Survey Area in May 2021**

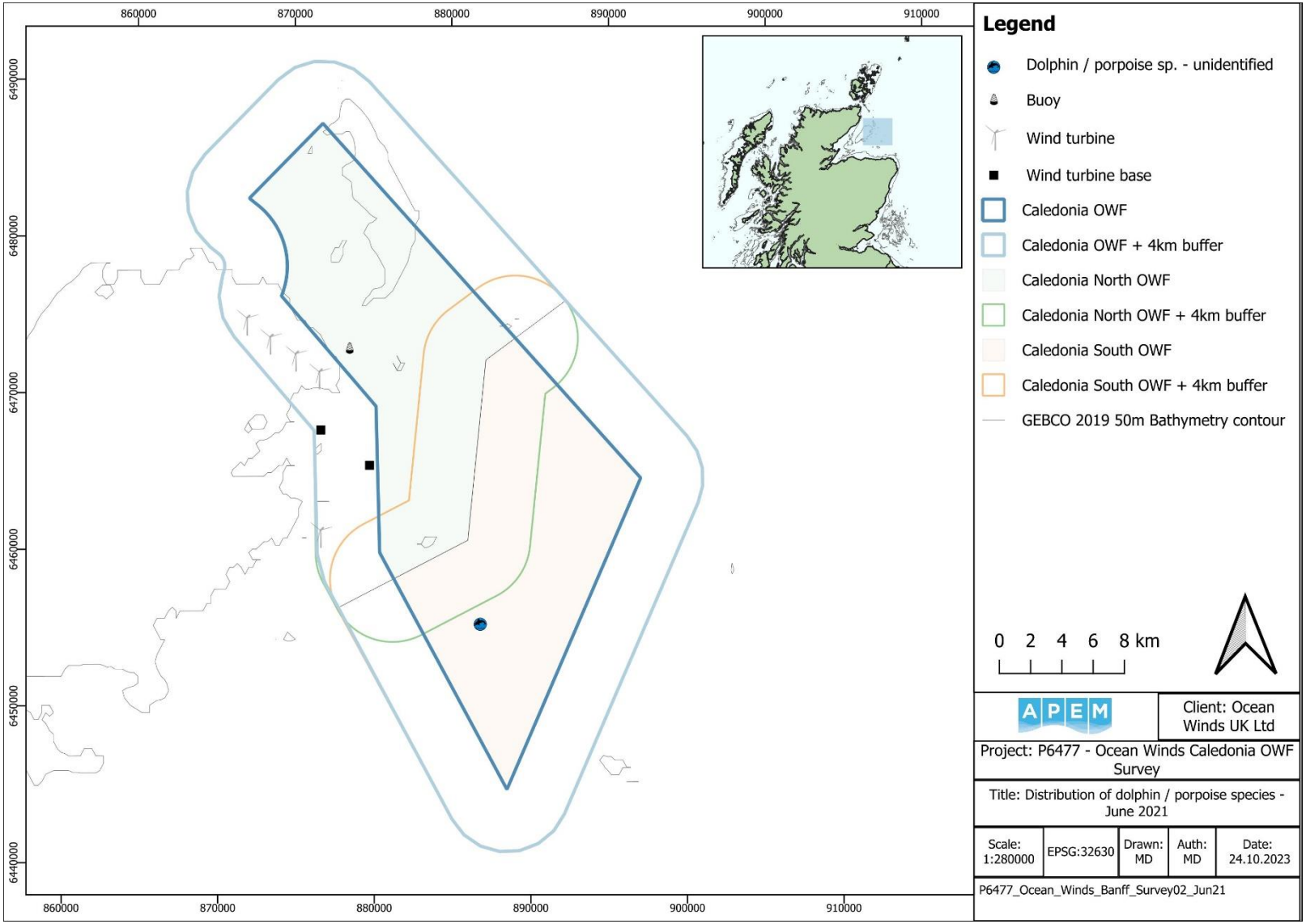



**Figure A4.412 Distribution of unidentified dolphin / porpoise species recorded in the Survey Area in June 2021**

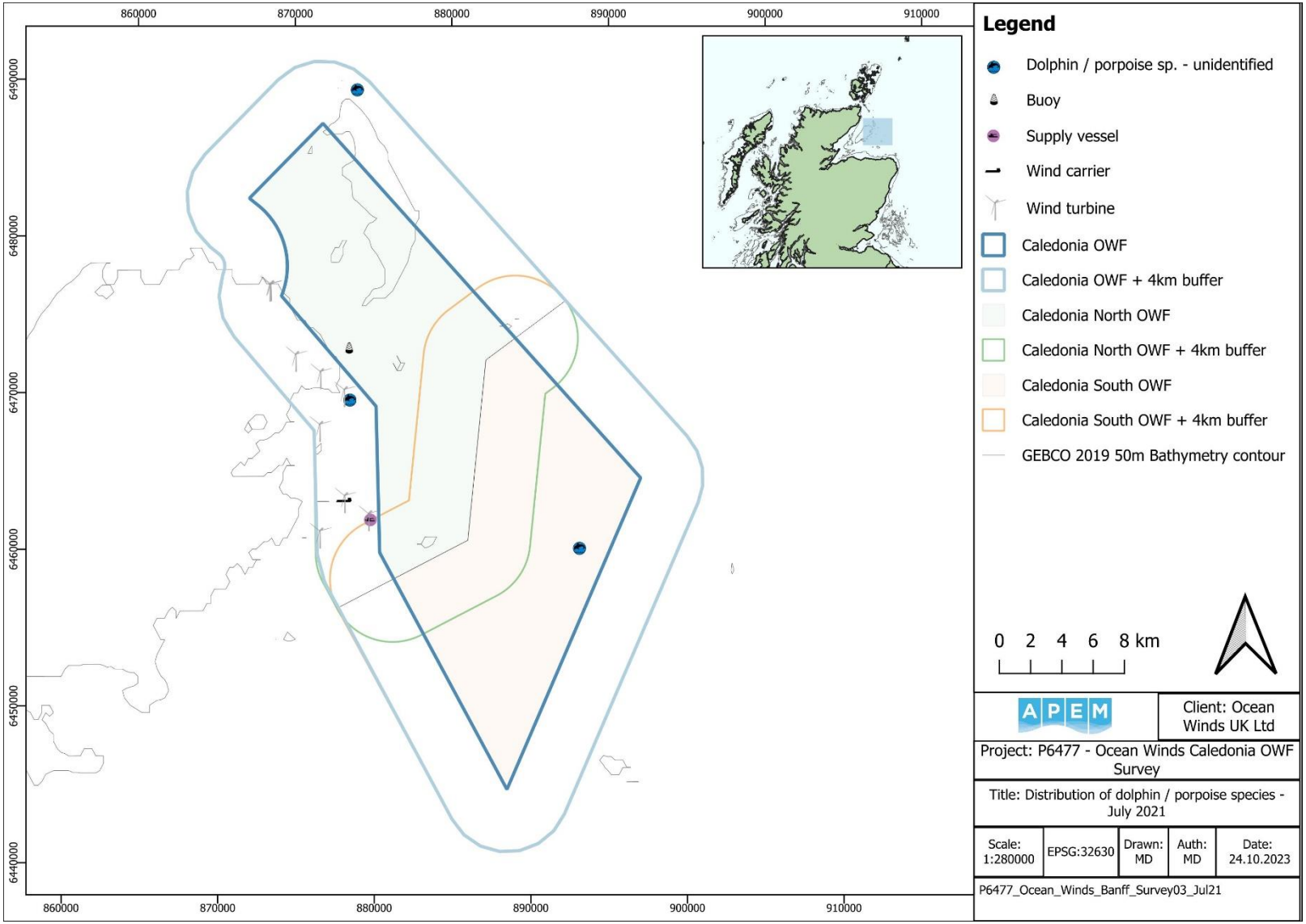



**Figure A4.413 Distribution of unidentified dolphin / porpoise species recorded in the Survey Area in July 2021**

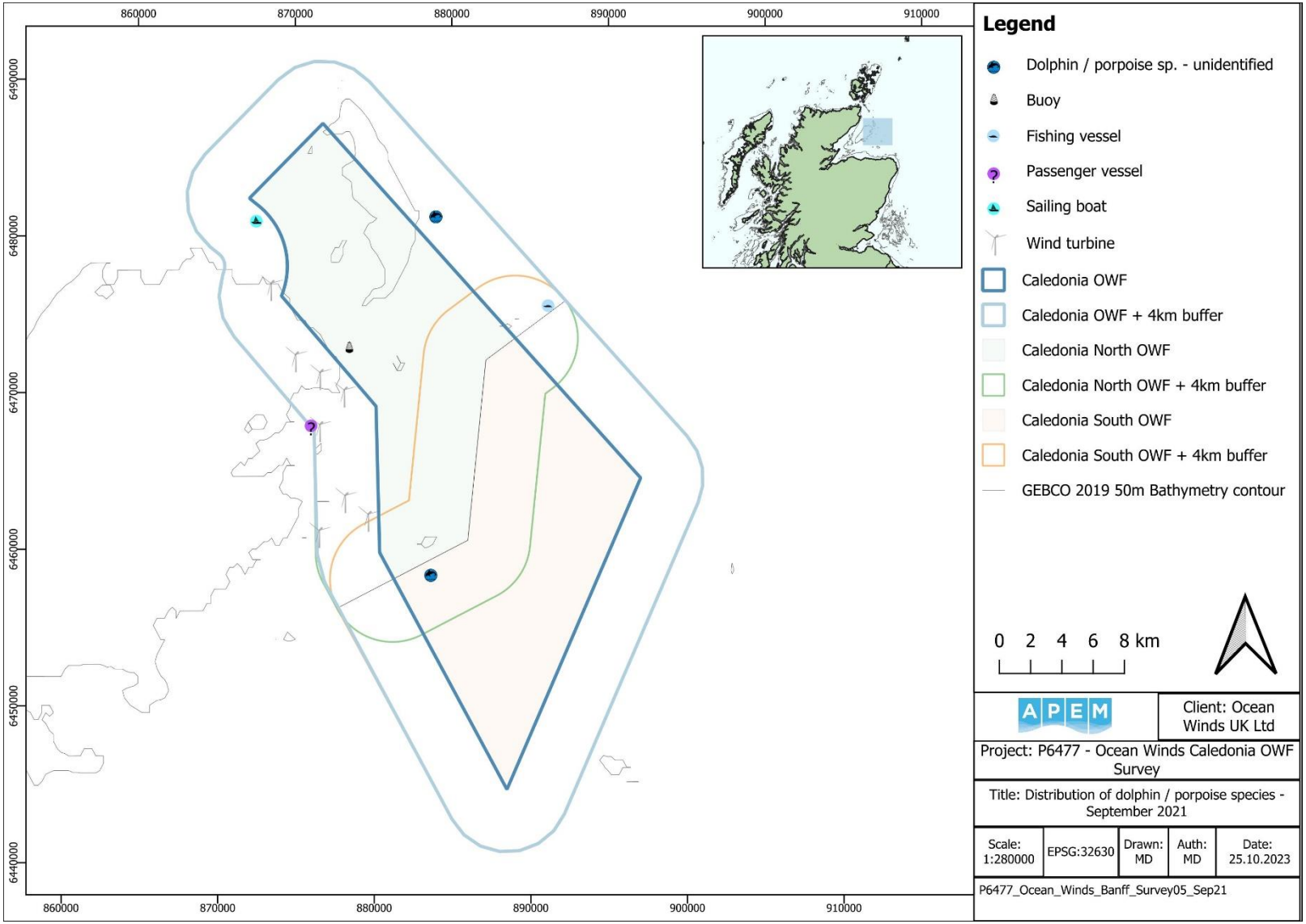



**Figure A4.414 Distribution of unidentified dolphin / porpoise species recorded in the Survey Area in September 2021**

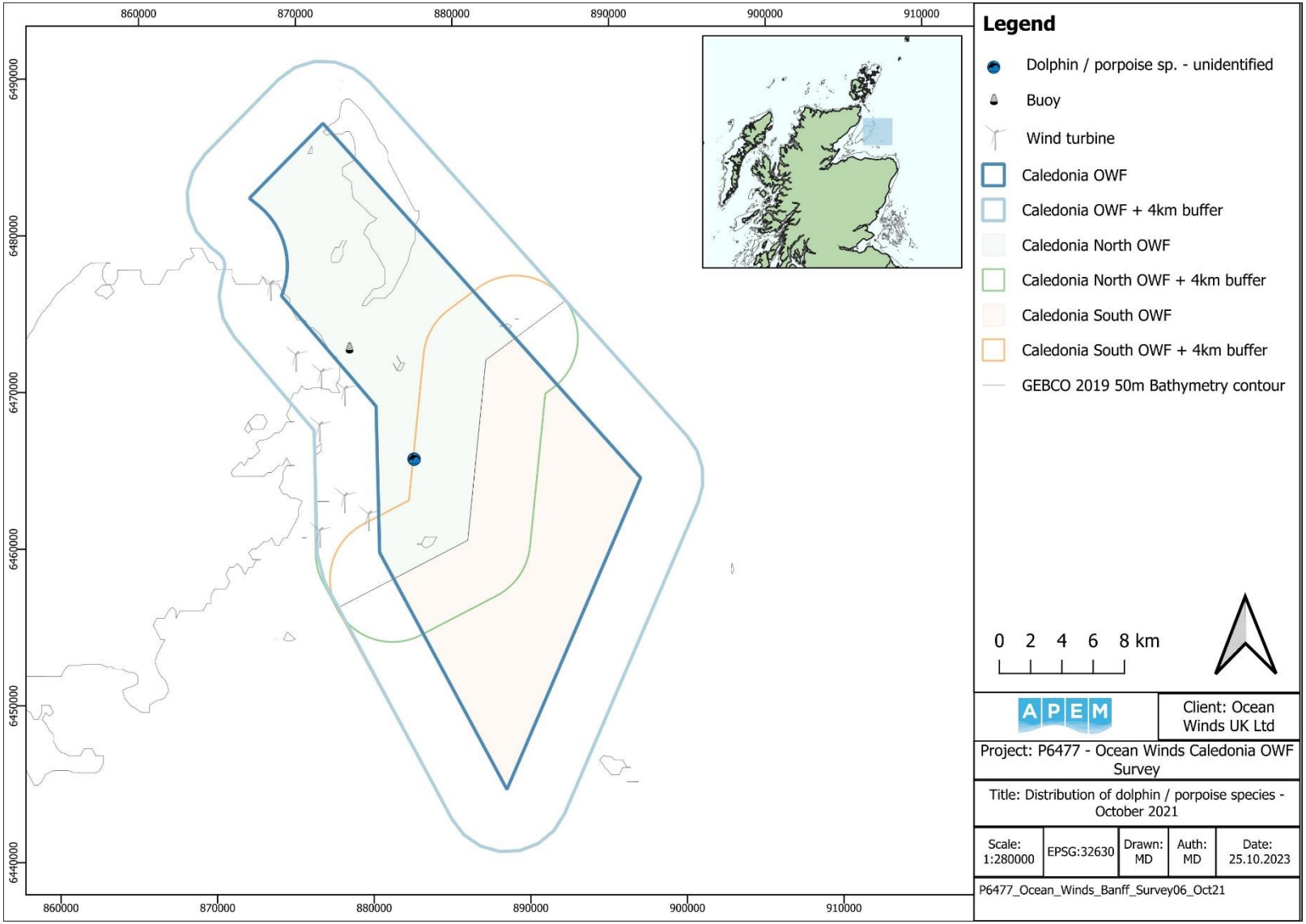



**Figure A4.415 Distribution of unidentified dolphin / porpoise species recorded in the Survey Area in October 2021**

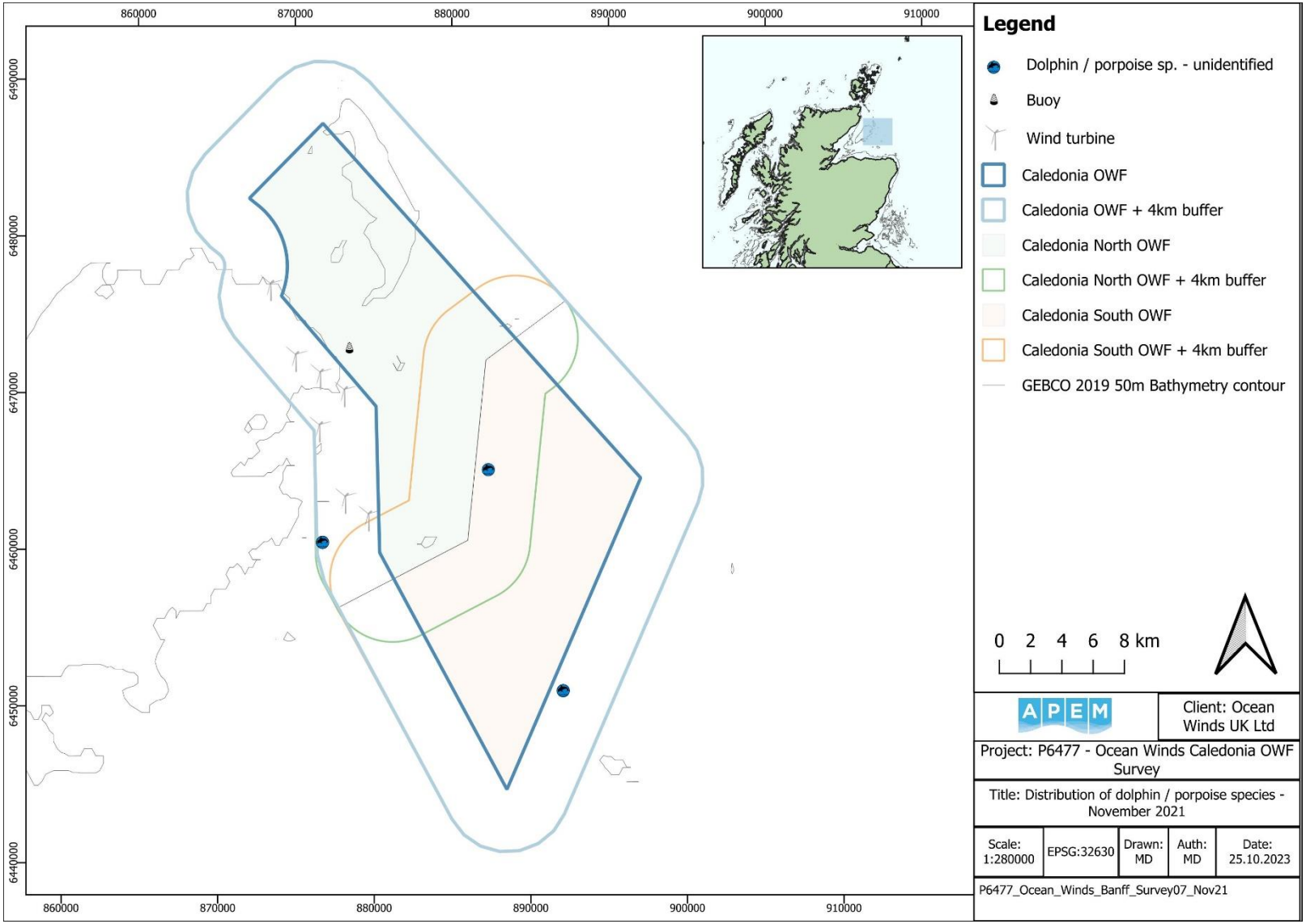



**Figure A4.416 Distribution of unidentified dolphin / porpoise species recorded in the Survey Area in November 2021**

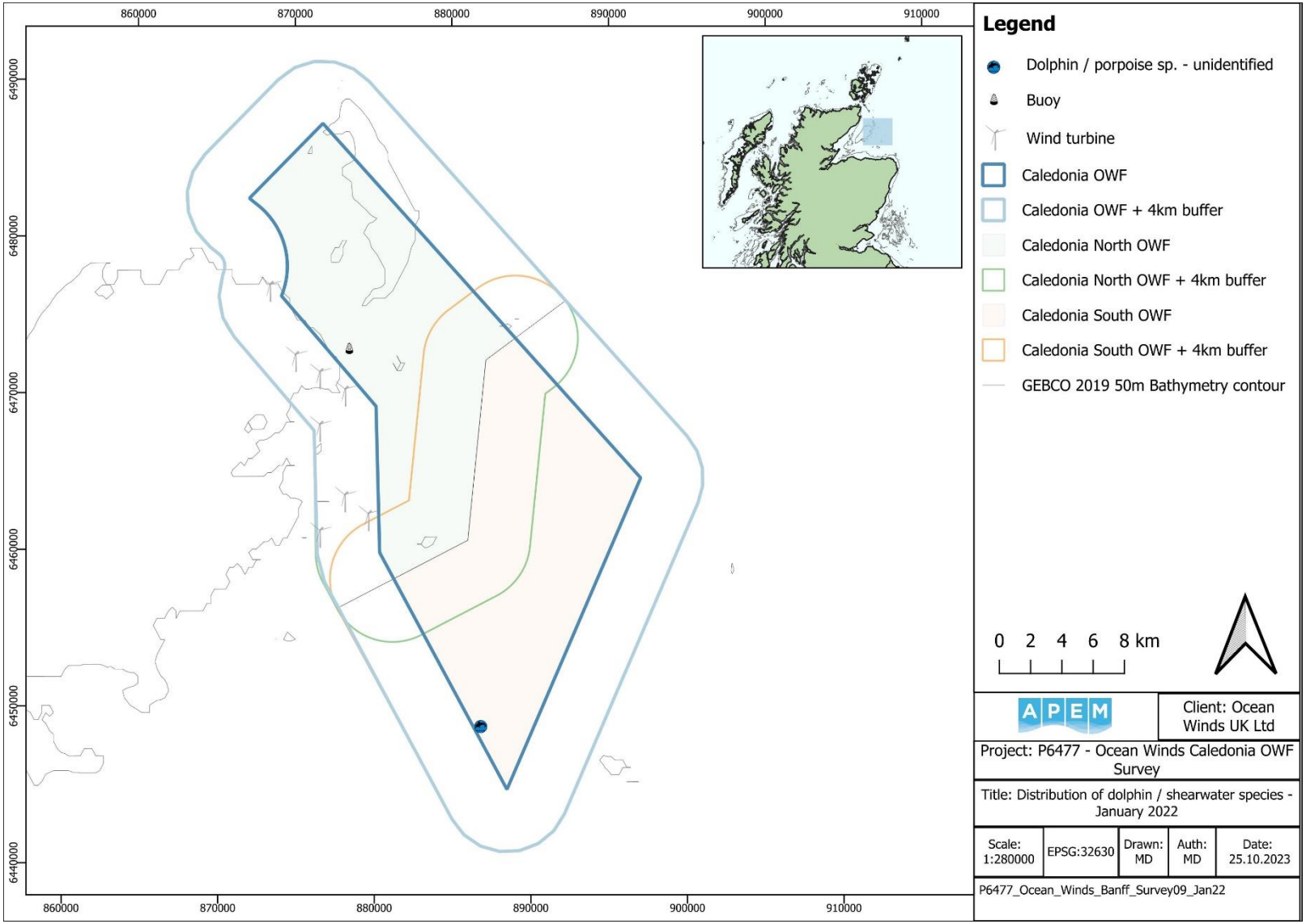



**Figure A4.417 Distribution of unidentified dolphin / porpoise species recorded in the Survey Area in January 2022**

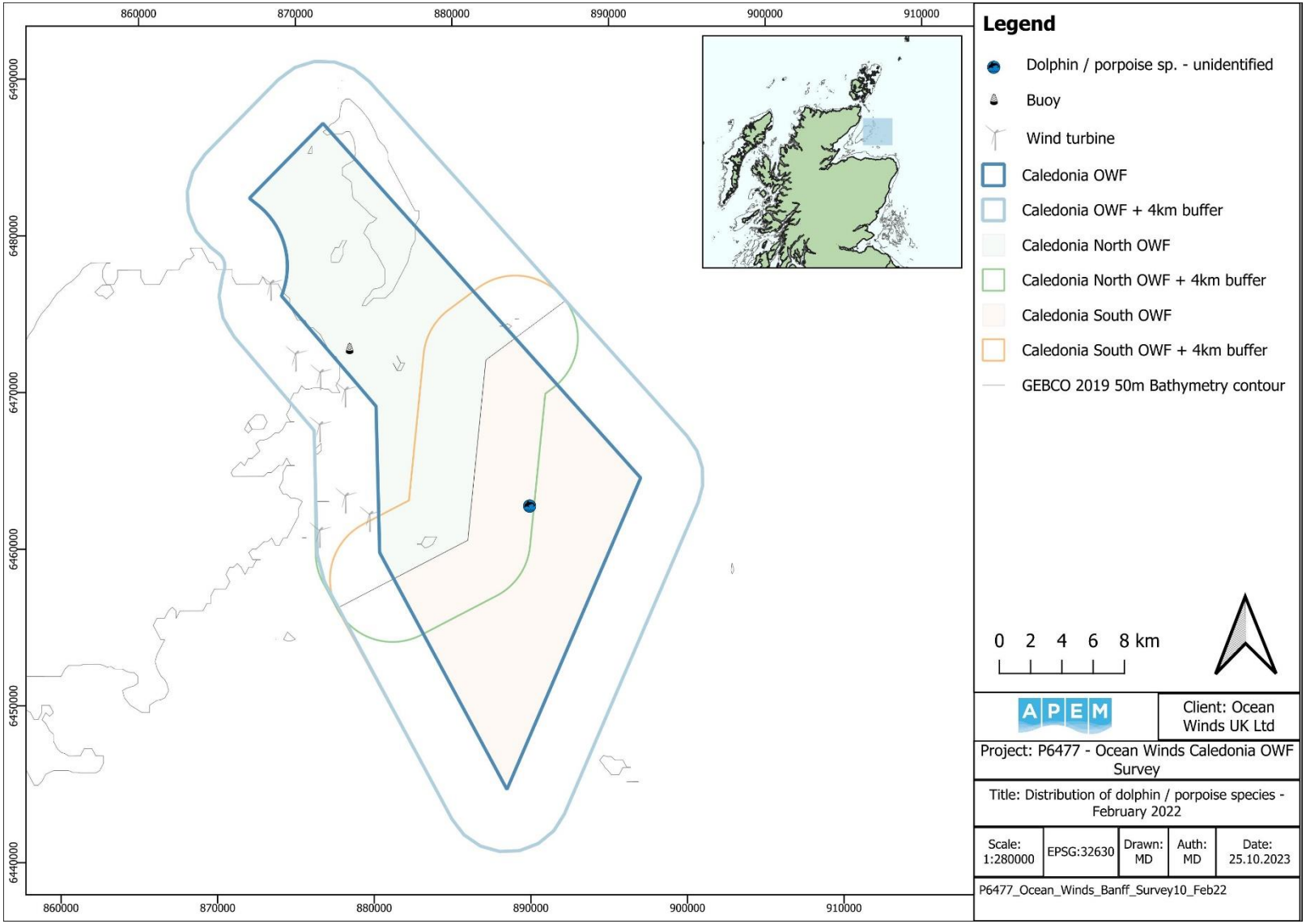



**Figure A4.418 Distribution of unidentified dolphin / porpoise species recorded in the Survey Area in February 2022**

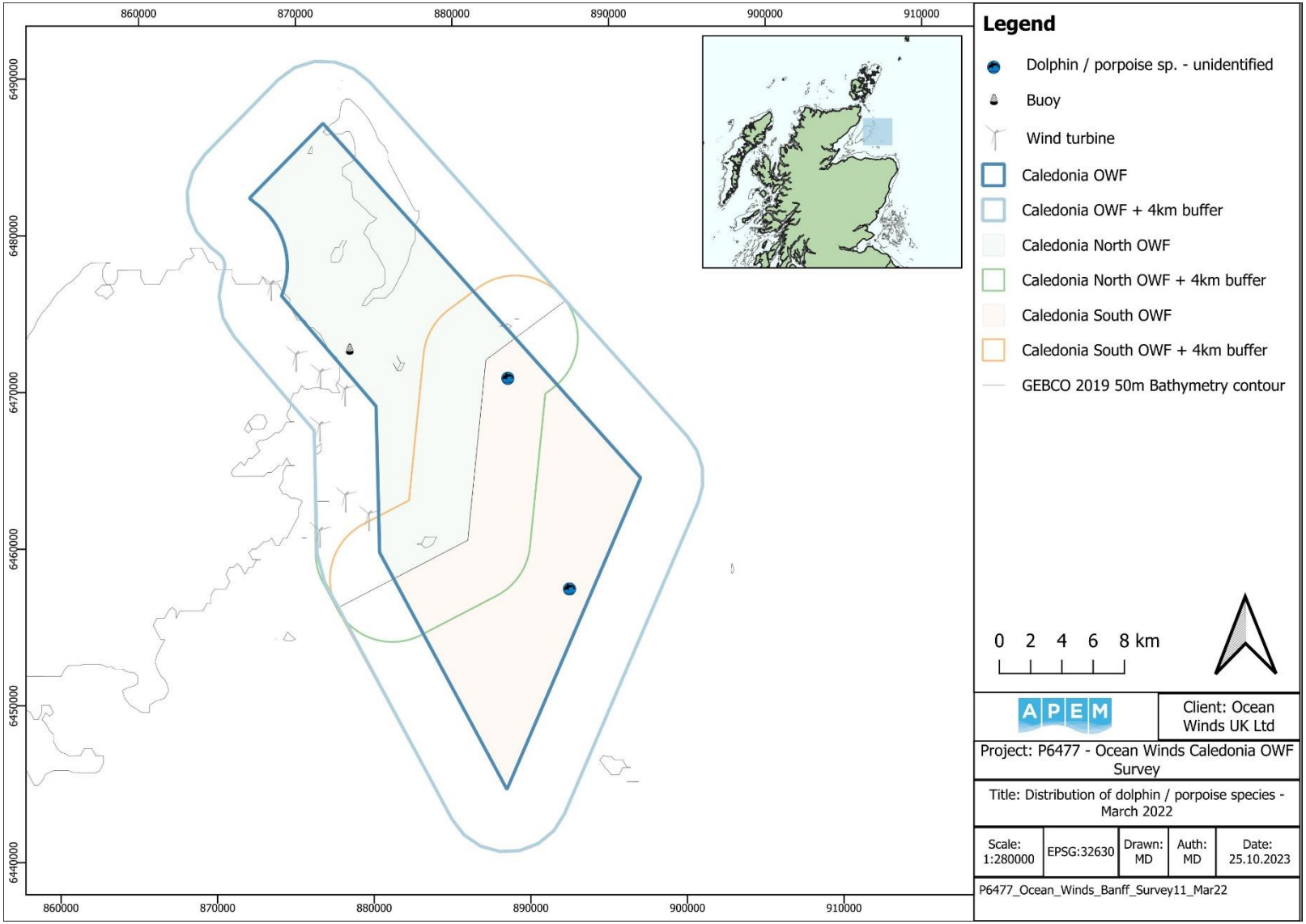



**Figure A4.419 Distribution of unidentified dolphin / porpoise species recorded in the Survey Area in March 2022**

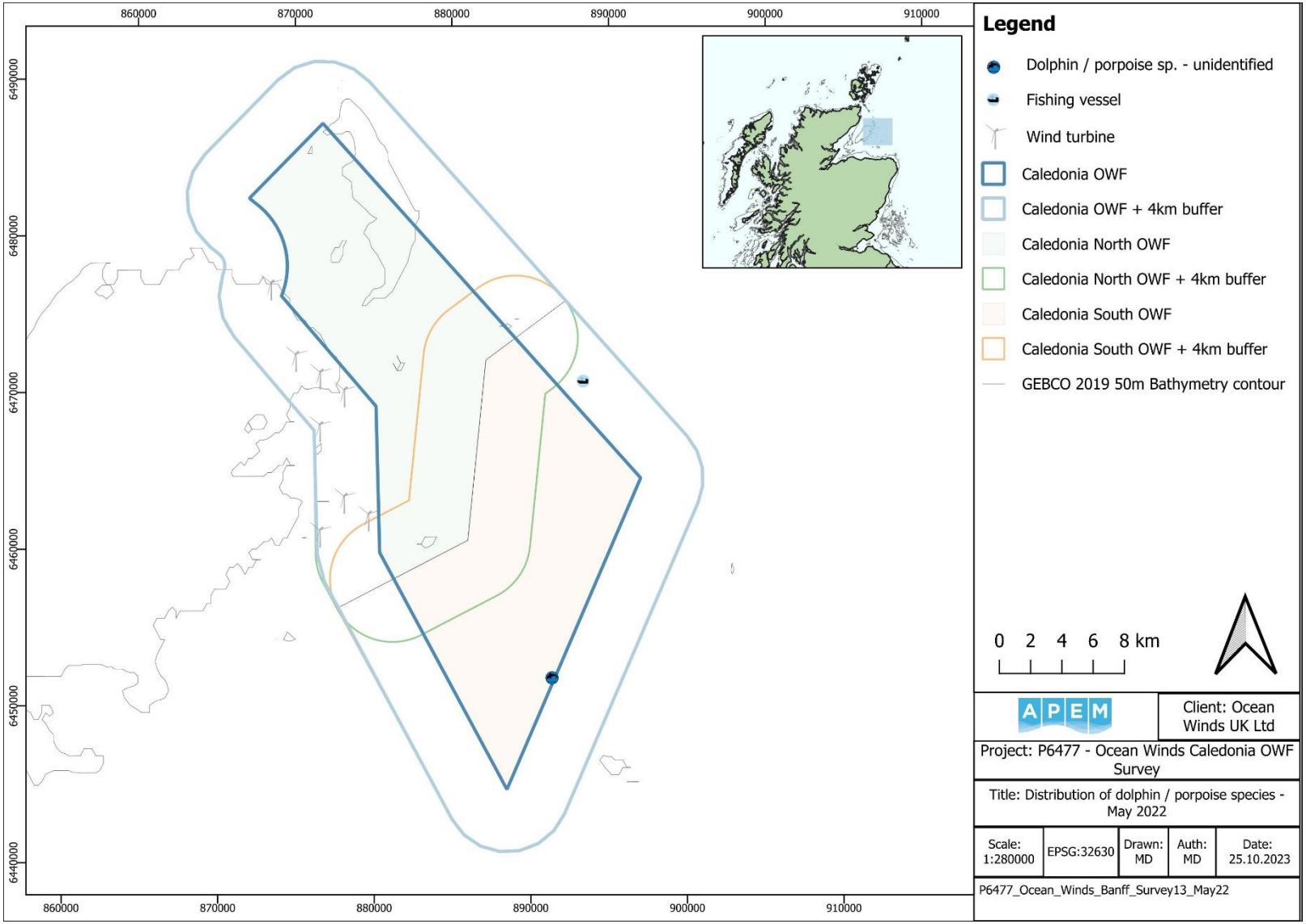



**Figure A4.420 Distribution of unidentified dolphin / porpoise species recorded in the Survey Area in May 2022**

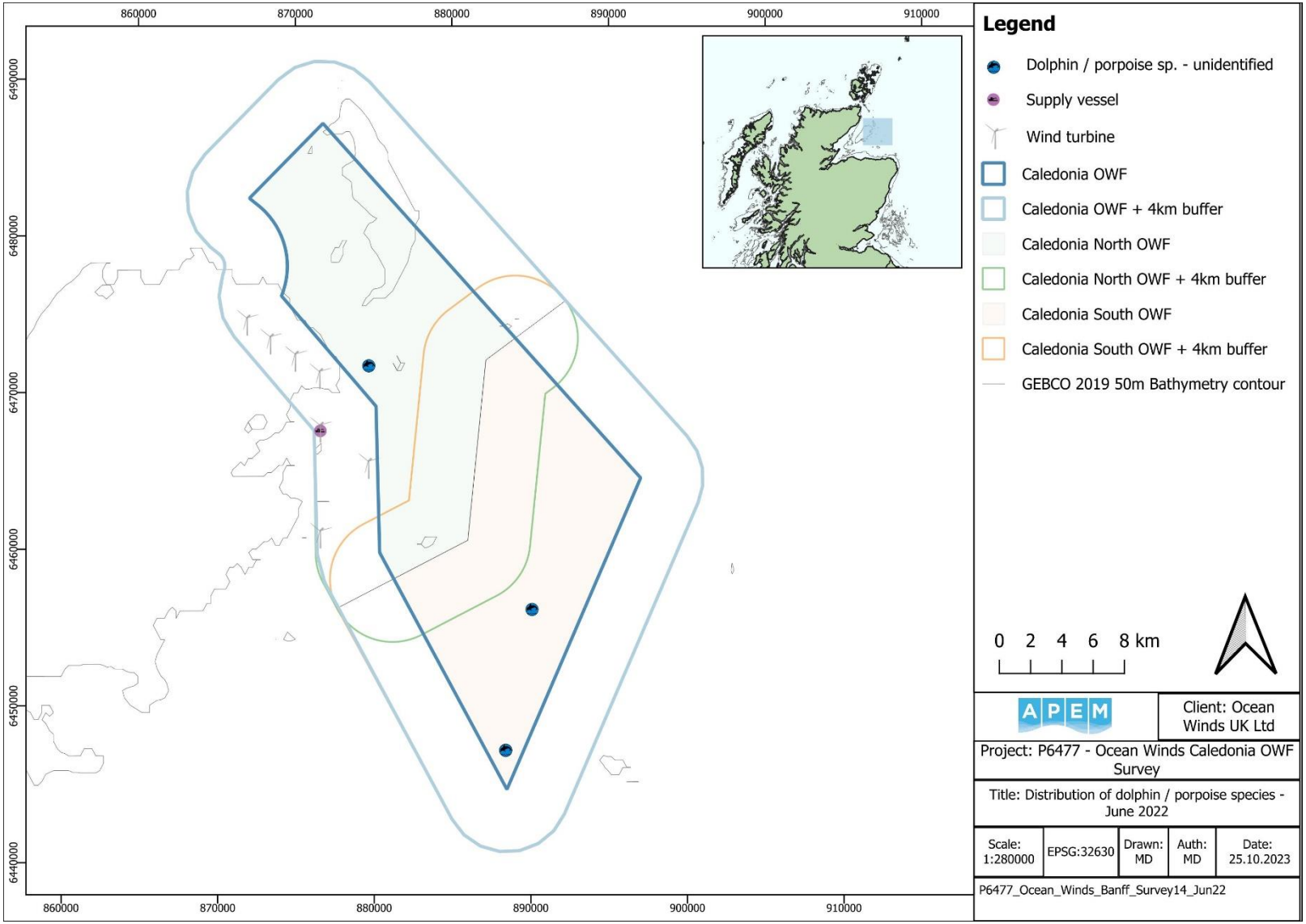



**Figure A4.421 Distribution of unidentified dolphin / porpoise species recorded in the Survey Area in June 2022**

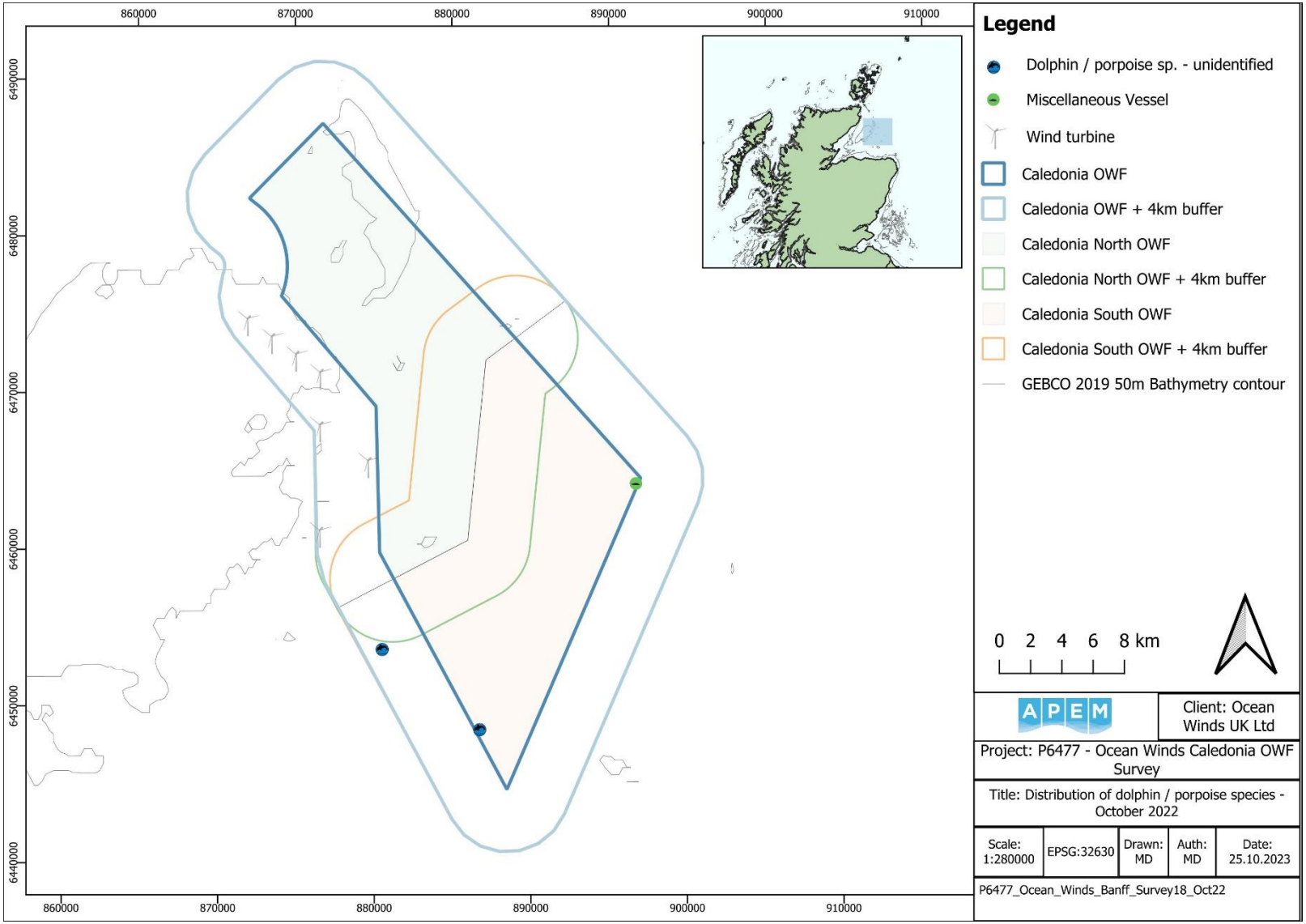



**Figure A4.422 Distribution of unidentified dolphin / porpoise species recorded in the Survey Area in October 2022**

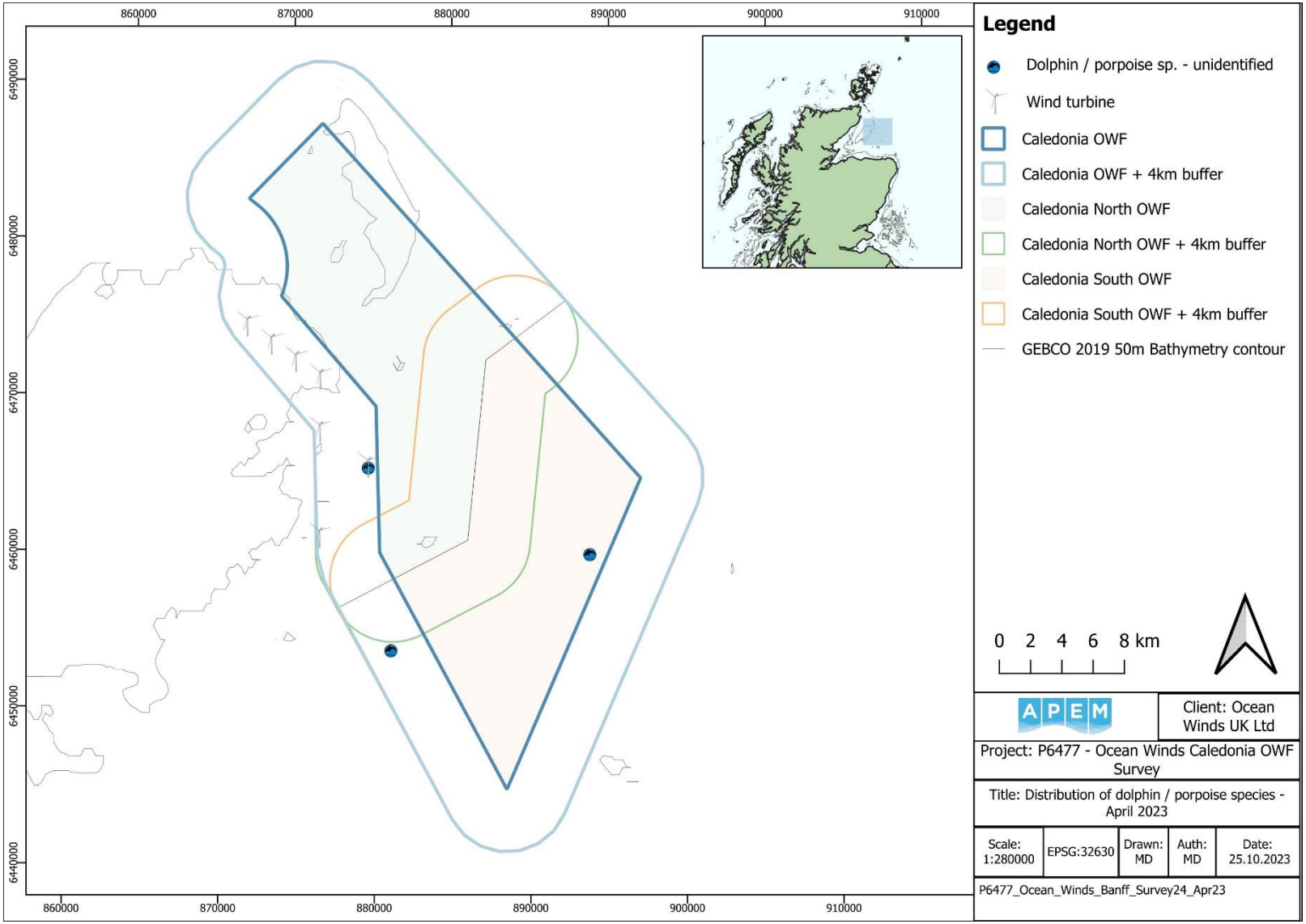



**Figure A4.423 Distribution of unidentified dolphin / porpoise species recorded in the Survey Area in April 2023**

## Common minke whale

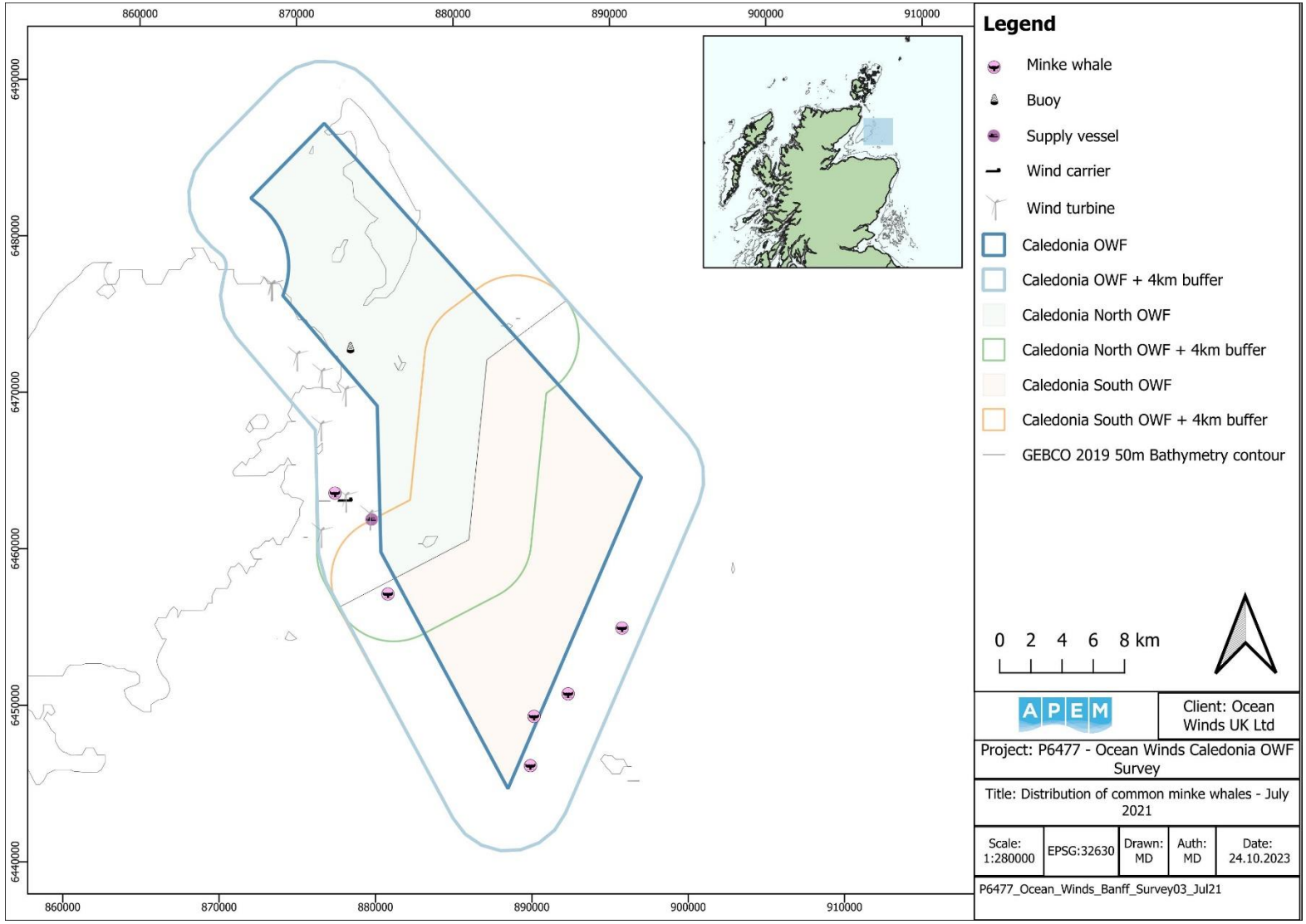



**Figure A4.424 Distribution of common minke whales recorded in the Survey Area in July 2021**

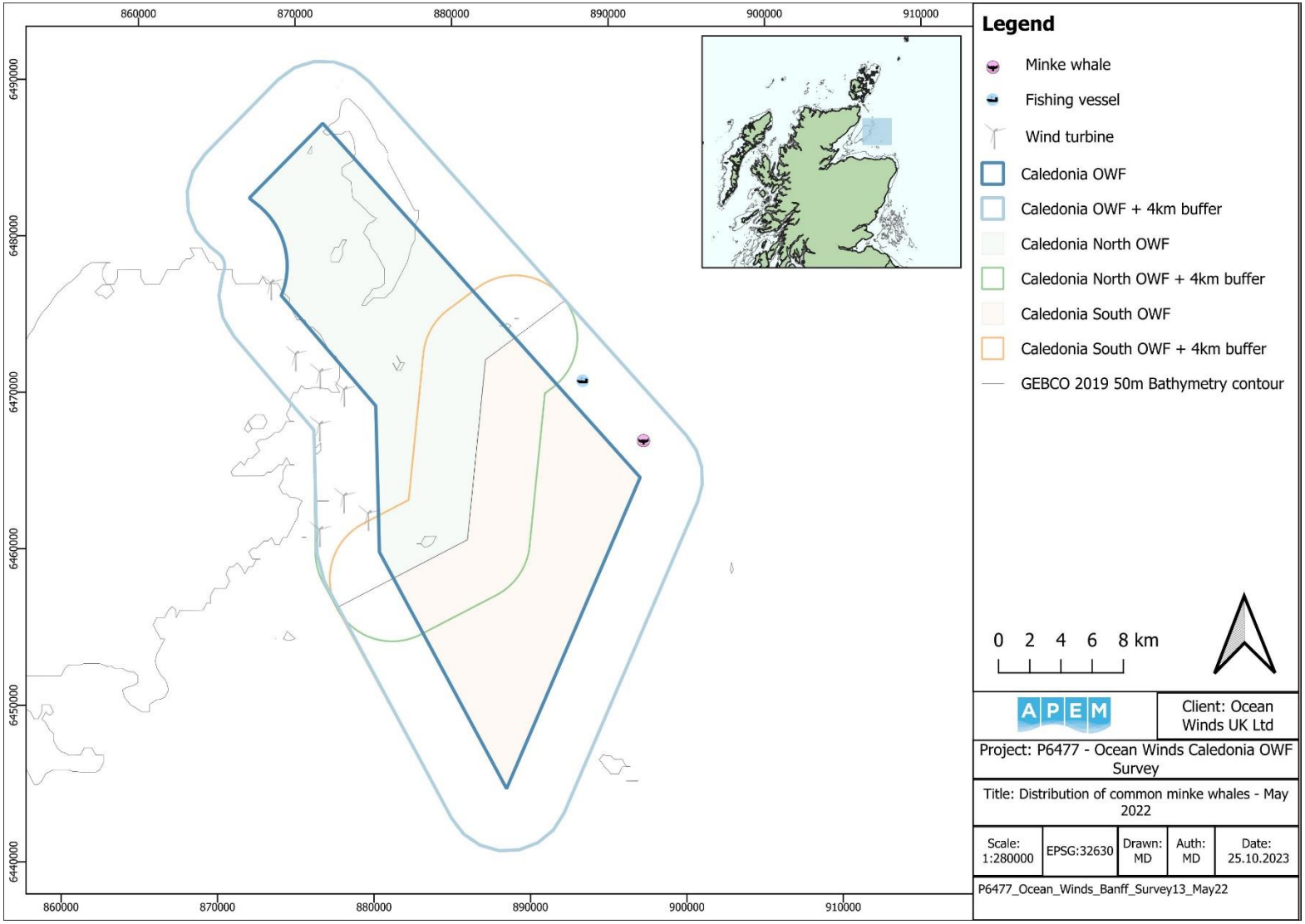



**Figure A4.425 Distribution of common minke whales recorded in the Survey Area in May 2022**

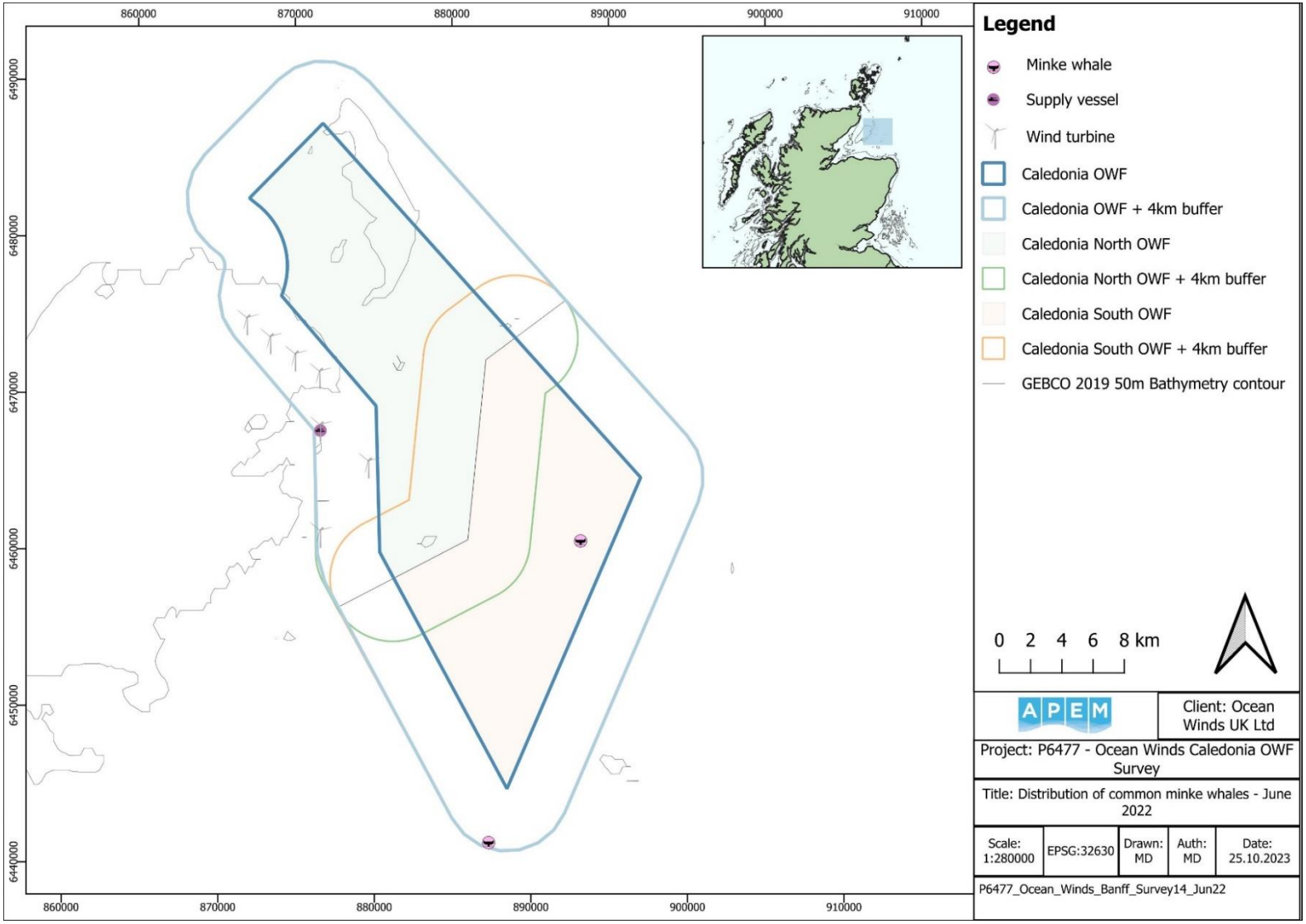



**Figure A4.426 Distribution of common minke whales recorded in the Survey Area in June 2022**

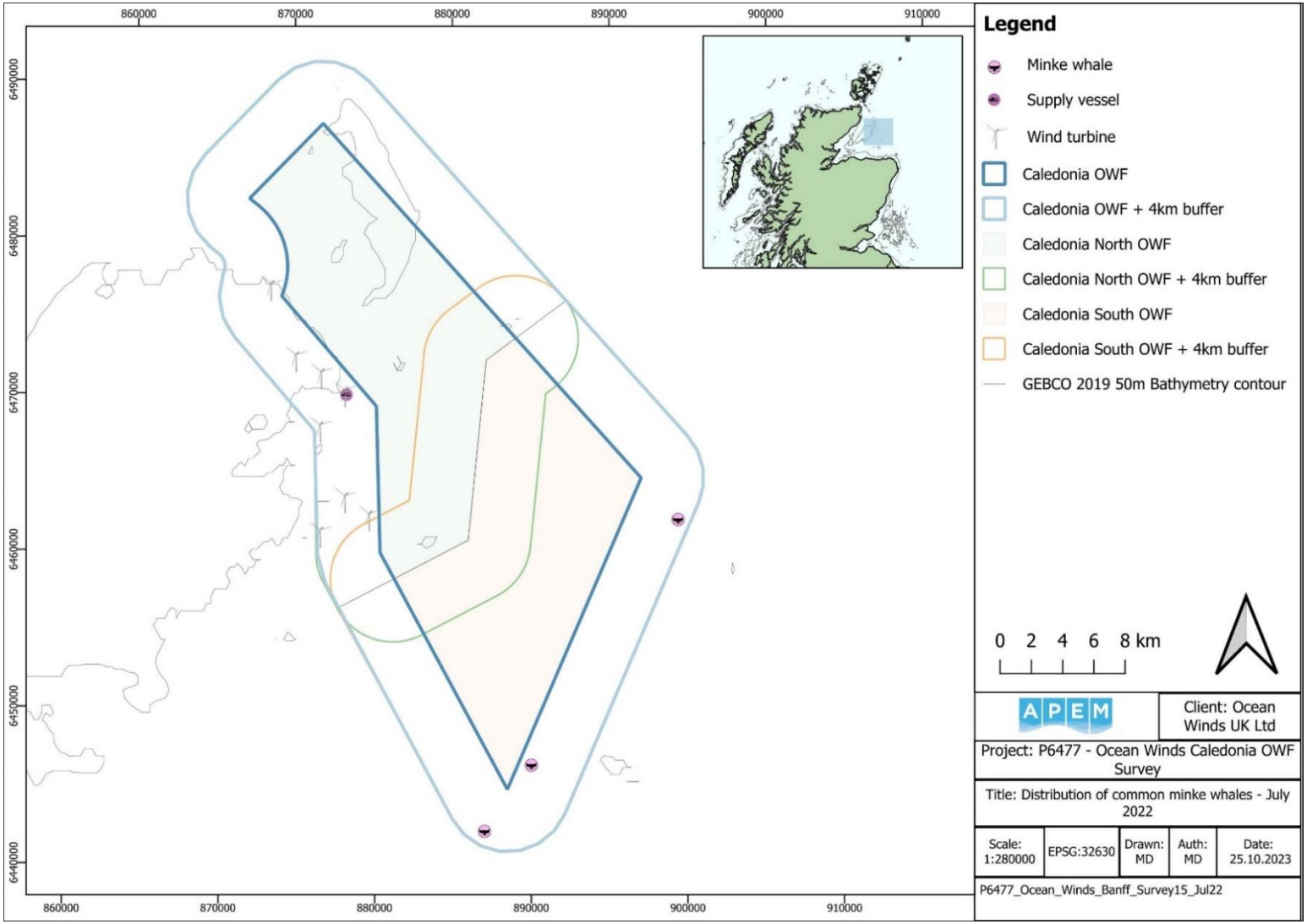



**Figure A4.427 Distribution of common minke whales recorded in the Survey Area in July 2022**

## Unidentified marine mammal species

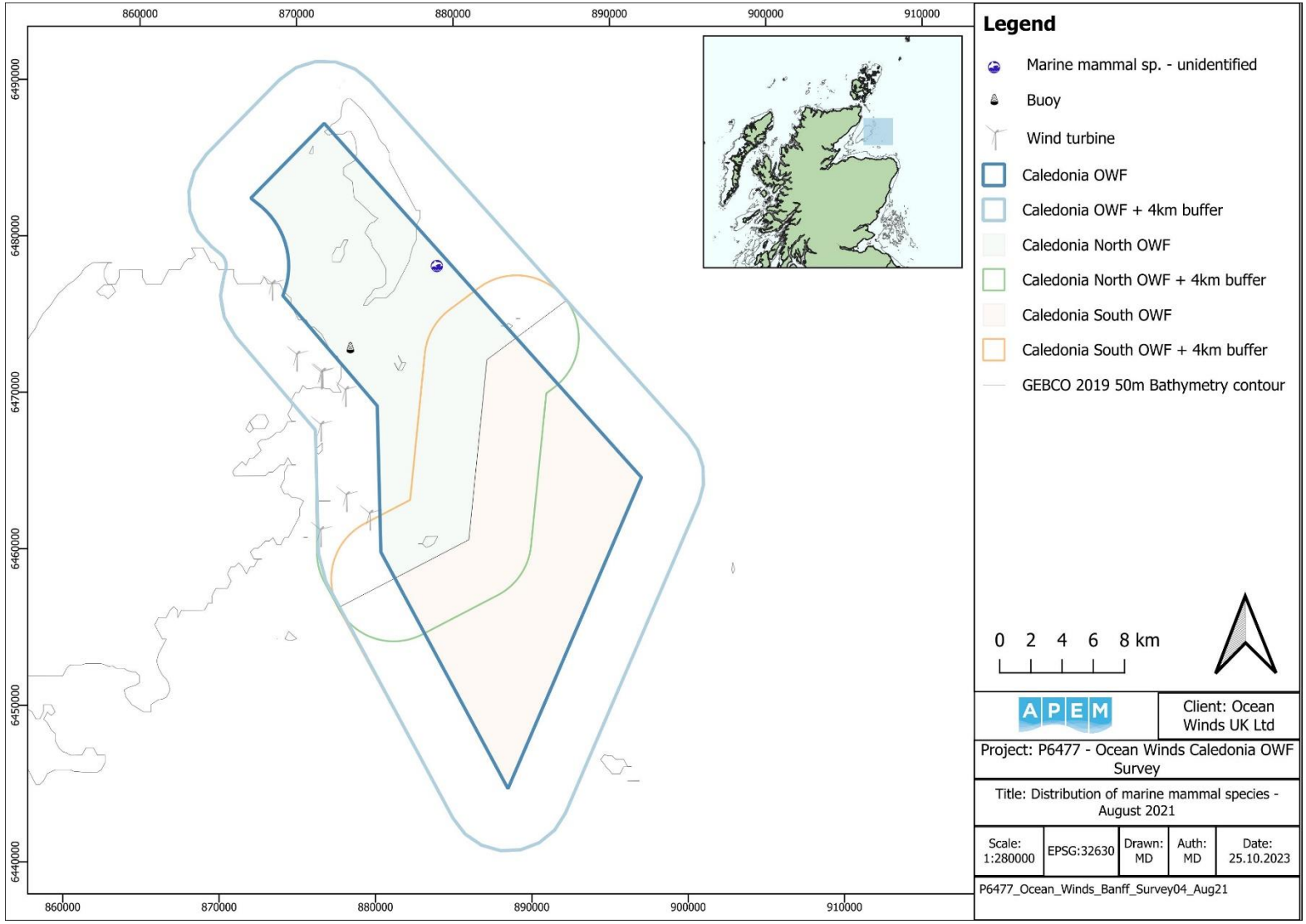



**Figure A4.428 Distribution of unidentified marine mammal species recorded in the Survey Area in August 2021**

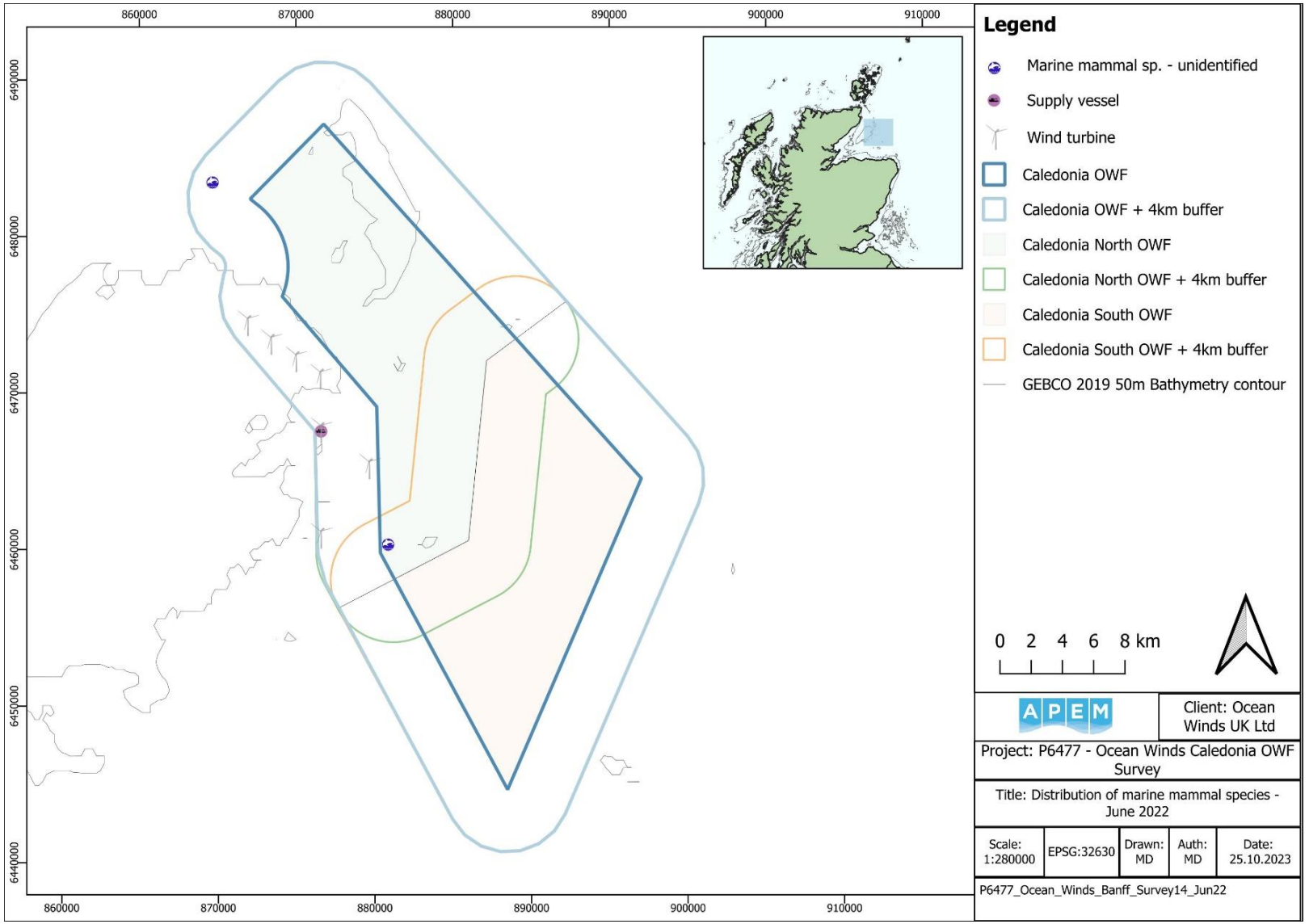



**Figure A4.429 Distribution of unidentified marine mammal species recorded in the Survey Area in June 2022**

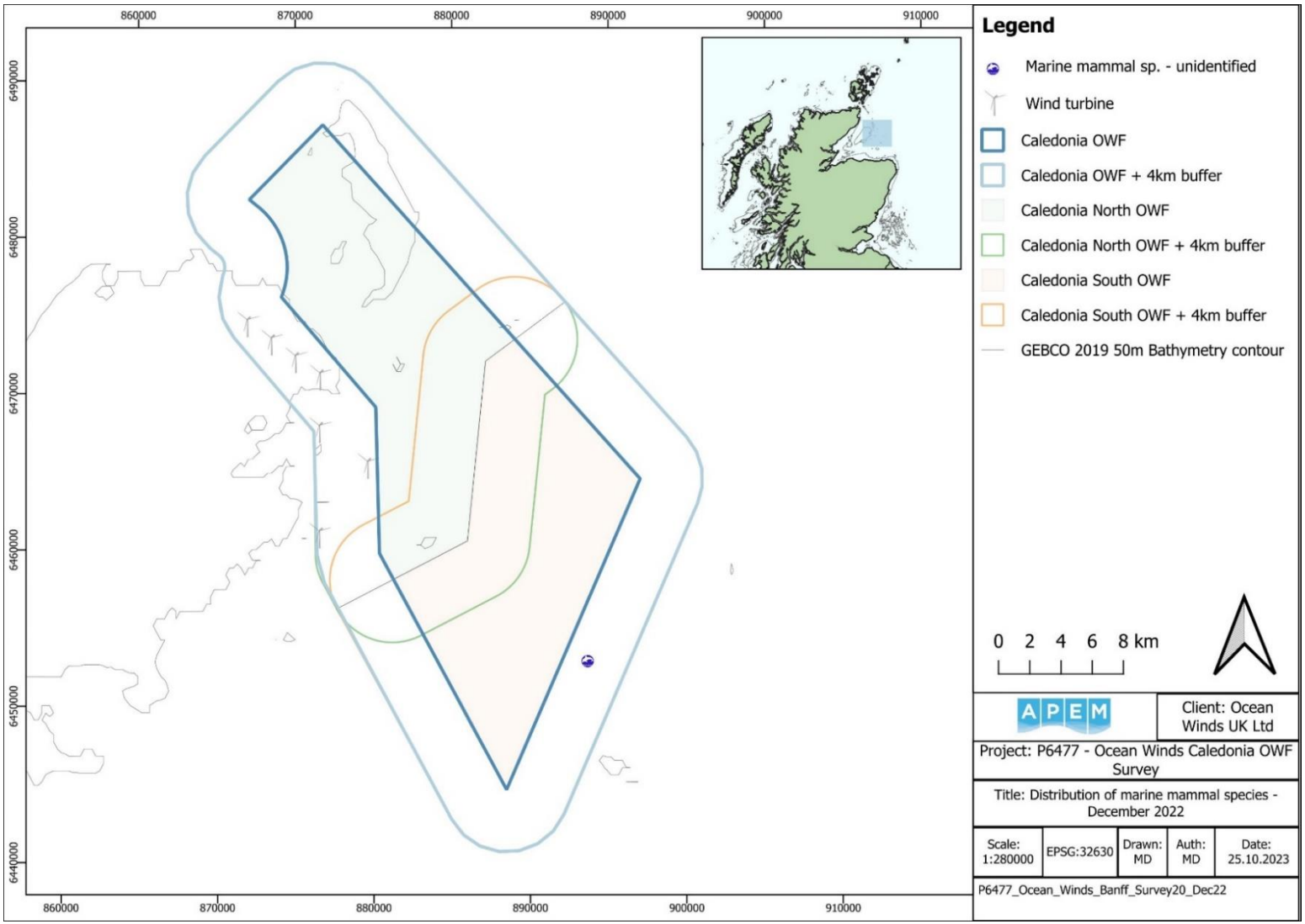



**Figure A4.430 Distribution of unidentified marine mammal species recorded in the Survey Area in December 2022**

## Basking shark

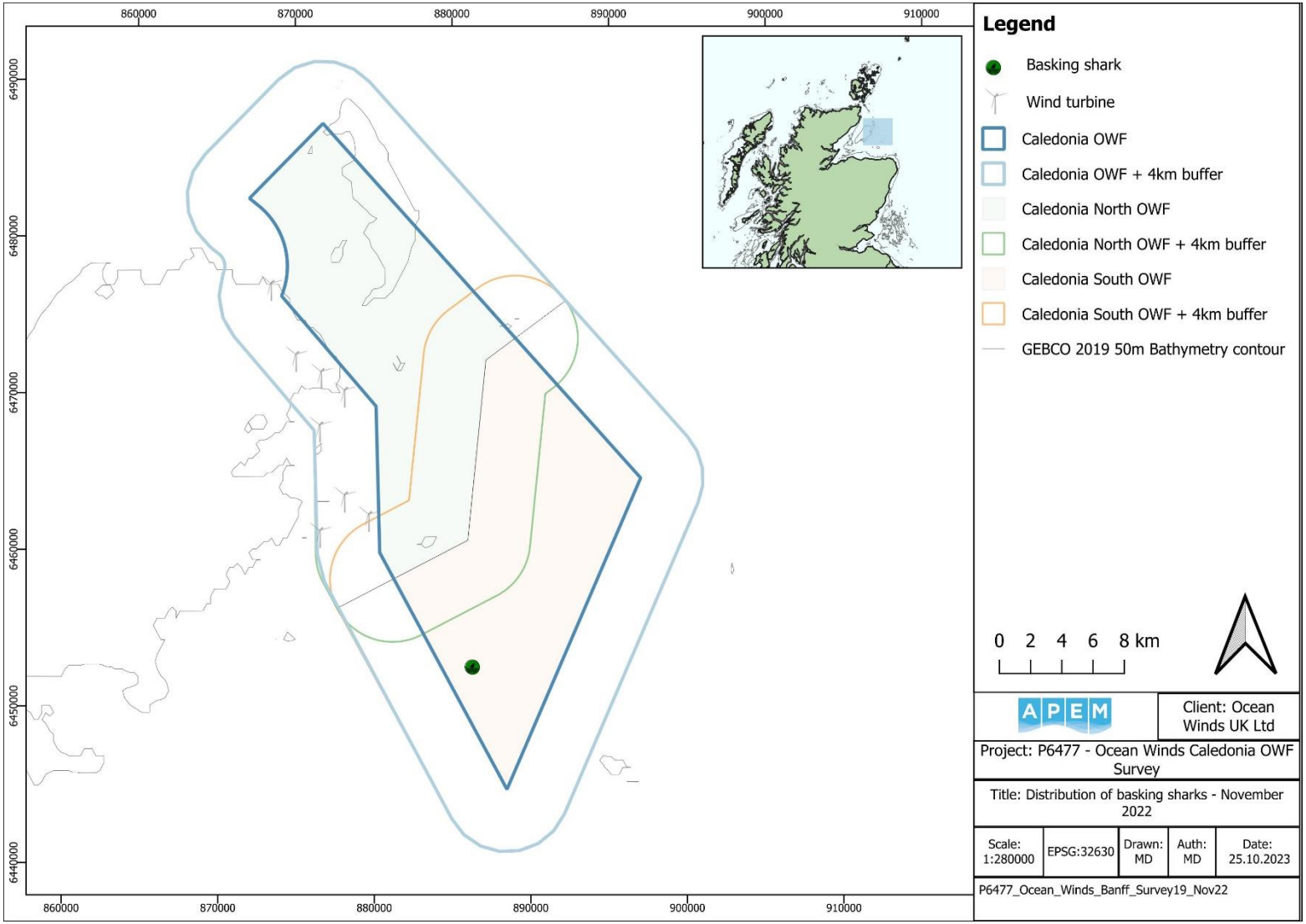



**Figure A4.431 Distribution of basking sharks recorded in the Survey Area in November 2022**

## Unidentified shark species

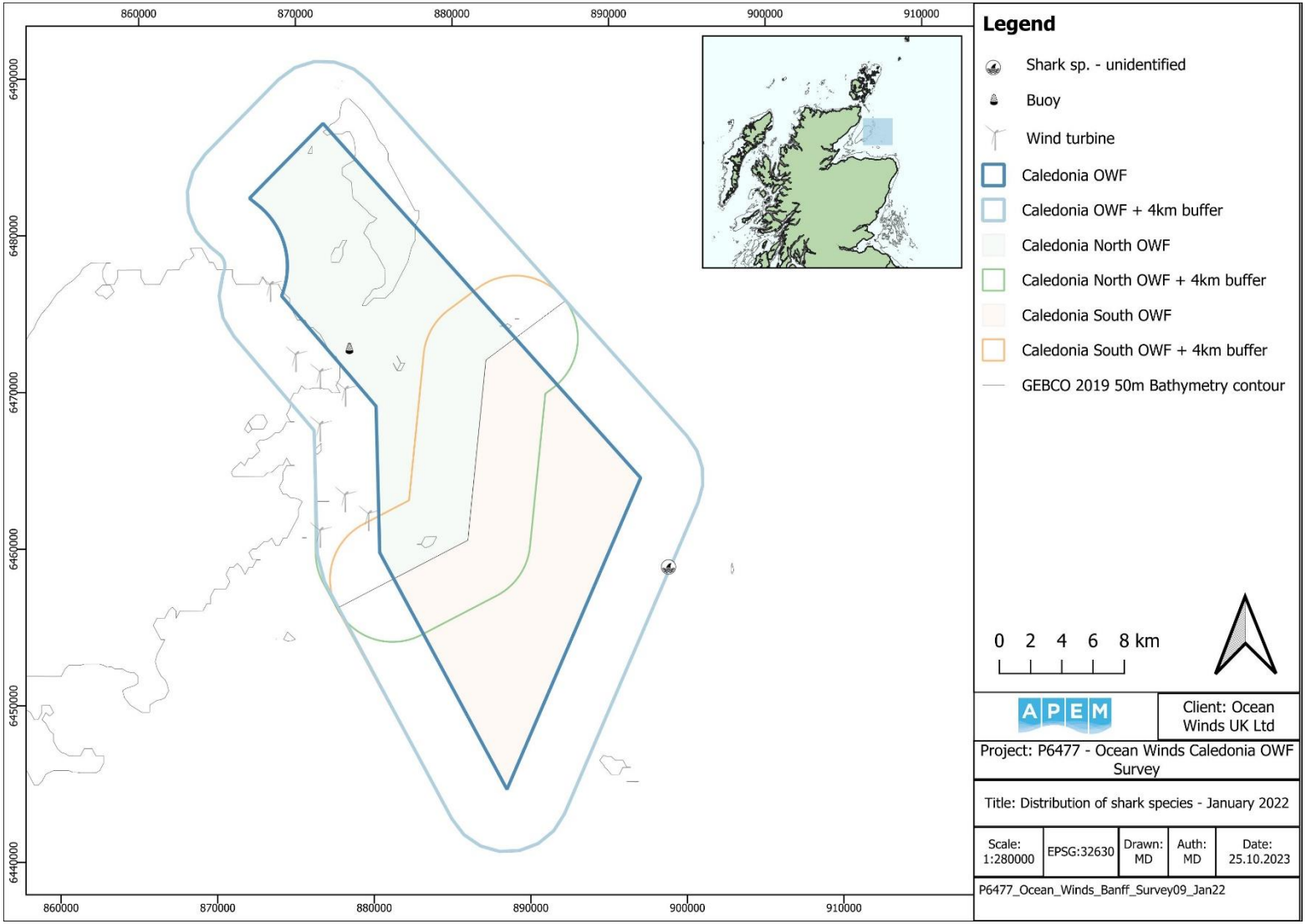


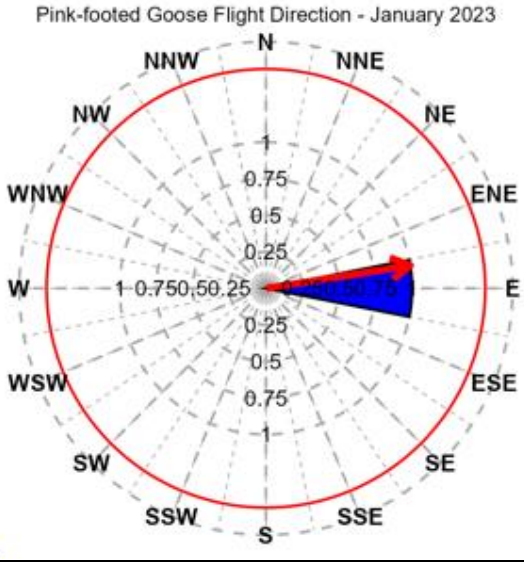

**Figure A4.432 Distribution of shark species recorded in the Survey Area in January 2022**

# Appendix 5 – Rose diagrams

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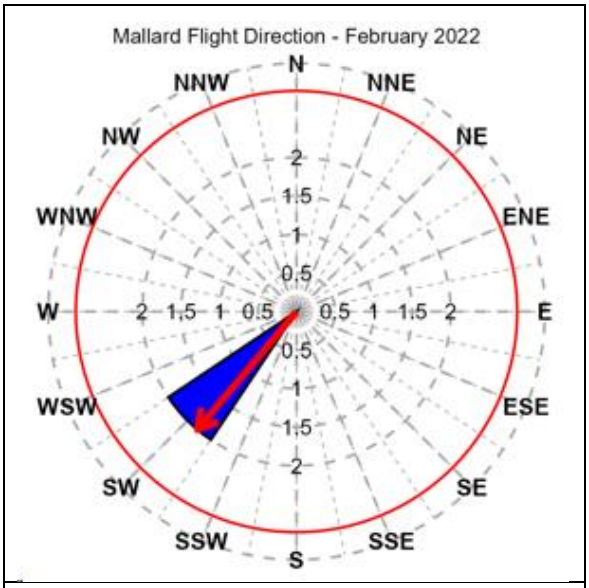
## Pink-footed goose




| | |
|---|---|
| Number of Observations | 1 |
| Mean Vector (μ) | 81.699 |
| Length of Mean Vector (r) | 1.000 |
| Rayleigh Test (Z) | 1.000 |
| Rayleigh Test (p) | 0.512 |
| **January 2023** | |

**Figure A5.433 Flight direction of pink-footed geese during the survey period**

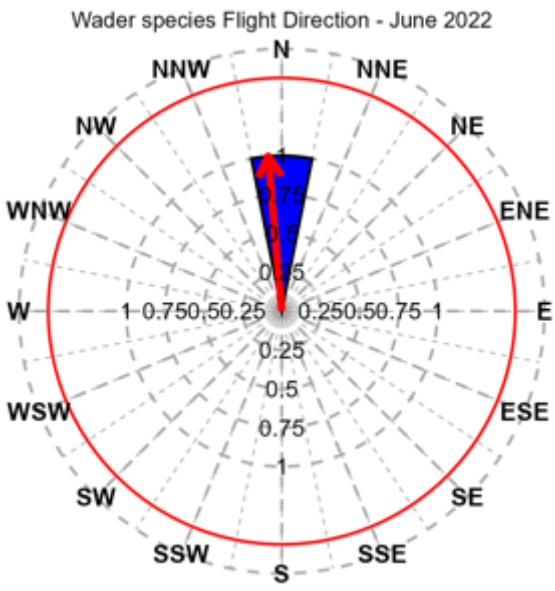
## Mallard




| | |
|---|---|
| Number of Observations | 2 |
| Mean Vector (μ) | 220.585 |
| Length of Mean Vector (r) | 0.999 |
| Rayleigh Test (Z) | 1.996 |
| Rayleigh Test (p) | 0.138 |
| **February 2022** | |

**Figure A5.434 Flight direction of mallards during the survey period**

## Wader species




| | |
|---|---|
| Number of Observations | 1 |
| Mean Vector (μ) | 355.343 |
| Length of Mean Vector (r) | 1.000 |
| Rayleigh Test (Z) | 1.000 |
| Rayleigh Test (p) | 0.512 |
| **June 2022** | |

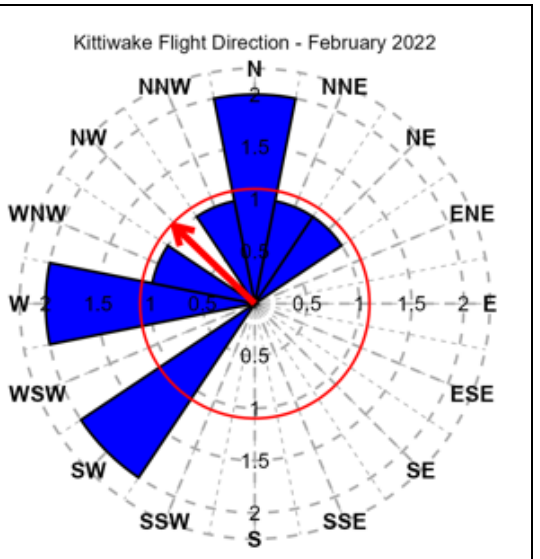
**Figure A5.435 Flight direction of wader species during the survey period**

## Kittiwake



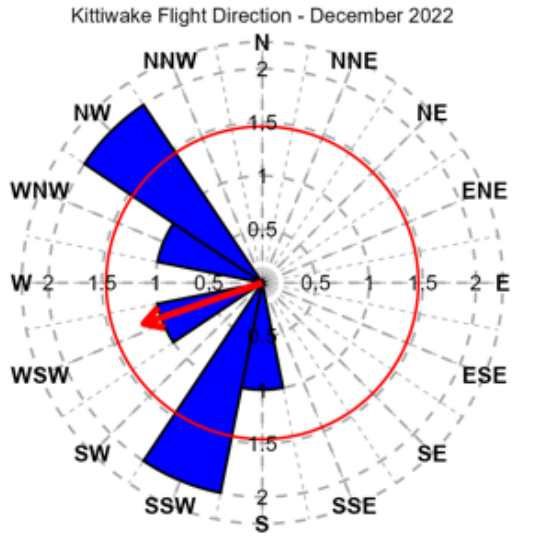

| | |
|---|---|
| Number of Observations | 8 |
| Mean Vector (μ) | 210.895 |
| Length of Mean Vector (r) | 0.463 |
| Rayleigh Test (Z) | 1.712 |
| Rayleigh Test (p) | 0.184 |

**a January 2022**



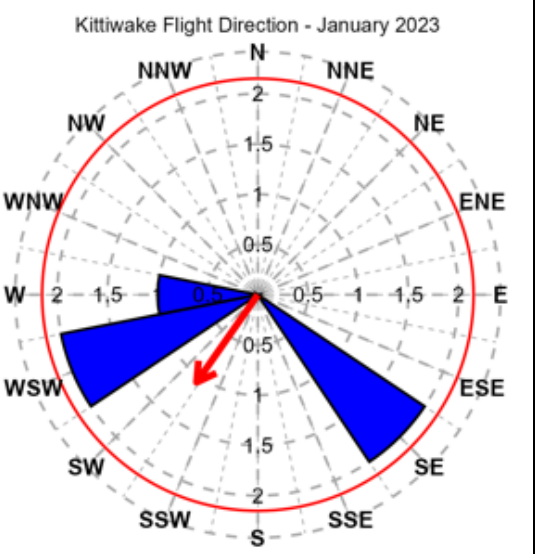

| | |
|---|---|
| Number of Observations | 10 |
| Mean Vector (μ) | 314.472 |
| Length of Mean Vector (r) | 0.536 |
| Rayleigh Test (Z) | 2.872 |
| Rayleigh Test (p) | 0.053 |

**b February 2022**



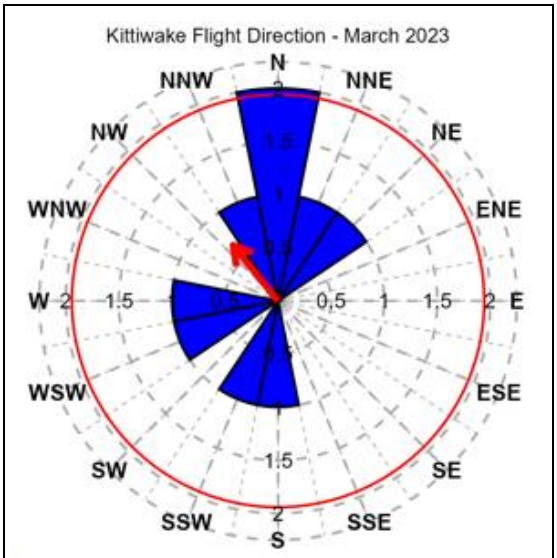

| | |
|---|---|
| Number of Observations | 7 |
| Mean Vector (μ) | 251.984 |
| Length of Mean Vector (r) | 0.585 |
| Rayleigh Test (Z) | 2.396 |
| Rayleigh Test (p) | 0.088 |

**c December 2022**




| | |
|---|---|
| Number of Observations | 5 |
| Mean Vector (μ) | 215.638 |
| Length of Mean Vector (r) | 0.532 |
| Rayleigh Test (Z) | 1.415 |
| Rayleigh Test (p) | 0.255 |

**d January 2023**

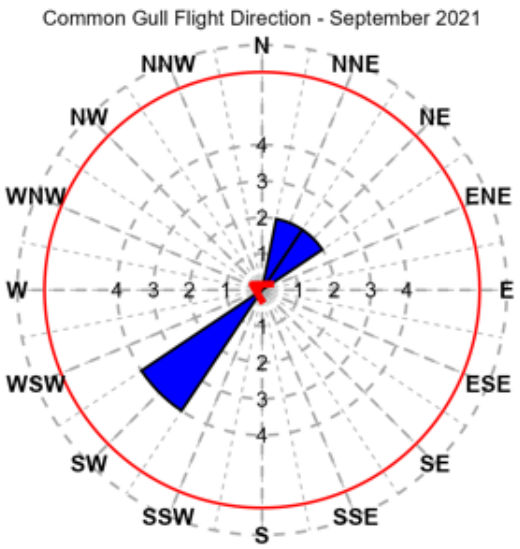



| | |
|---|---|
| Number of Observations | 9 |
| Mean Vector (μ) | 321.313 |
| Length of Mean Vector (r) | 0.336 |
| Rayleigh Test (Z) | 1.019 |
| Rayleigh Test (p) | 0.372 |

**e March 2023**

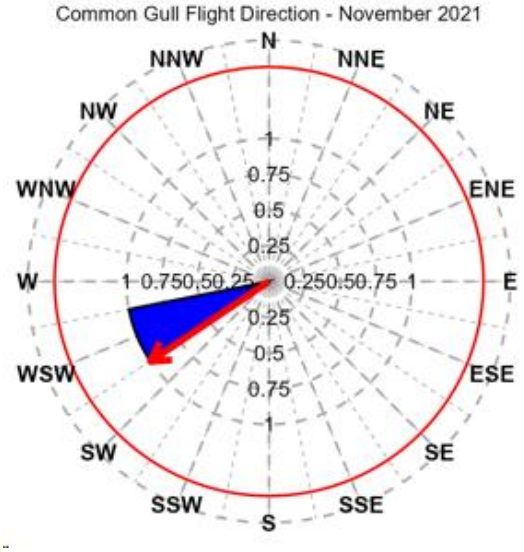
**Figure A5.436 Flight direction of kittiwakes during the survey period**

## Common gull



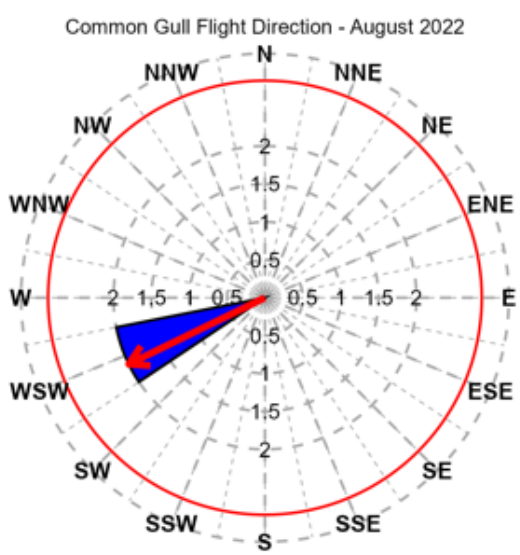

| | |
|---|---|
| Number of Observations | 8 |
| Mean Vector (μ) | 299.408 |
| Length of Mean Vector (r) | 0.078 |
| Rayleigh Test (Z) | 0.9 |
| Rayleigh Test (p) | 0.955 |

**a September 2021**



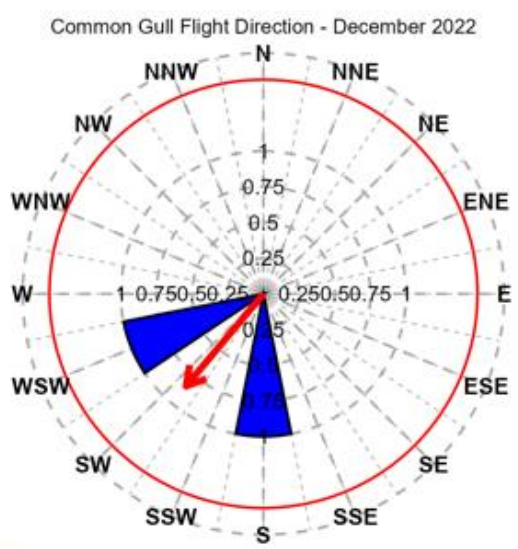

| | |
|---|---|
| Number of Observations | 1 |
| Mean Vector (μ) | 236.974 |
| Length of Mean Vector (r) | 1.000 |
| Rayleigh Test (Z) | 1.000 |
| Rayleigh Test (p) | 0.512 |

**b November 2021**




| | |
|---|---|
| Number of Observations | 2 |
| Mean Vector (μ) | 244.259 |
| Length of Mean Vector (r) | 0.999 |
| Rayleigh Test (Z) | 1.997 |
| Rayleigh Test (p) | 0.138 |

**c August 2022**

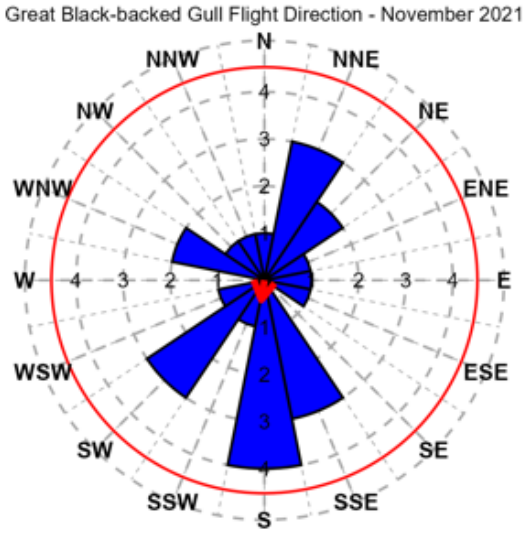



| | |
|---|---|
| Number of Observations | 2 |
| Mean Vector (μ) | 220.183 |
| Length of Mean Vector (r) | 0.844 |
| Rayleigh Test (Z) | 1.425 |
| Rayleigh Test (p) | 0.276 |

**d December 2022**

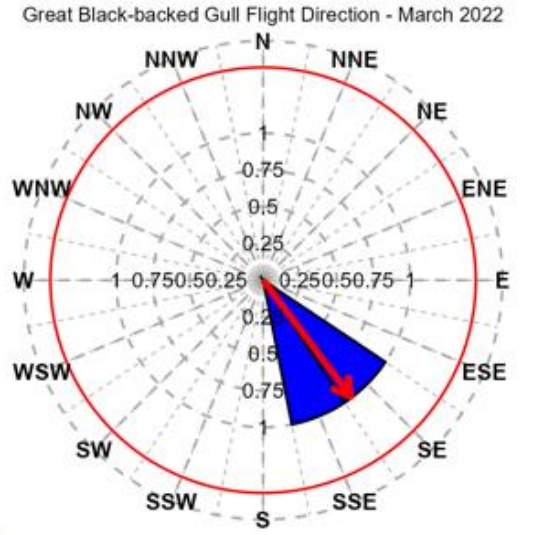
**Figure A5.437 Flight direction of common gulls during the survey period**

## Great black-backed gull



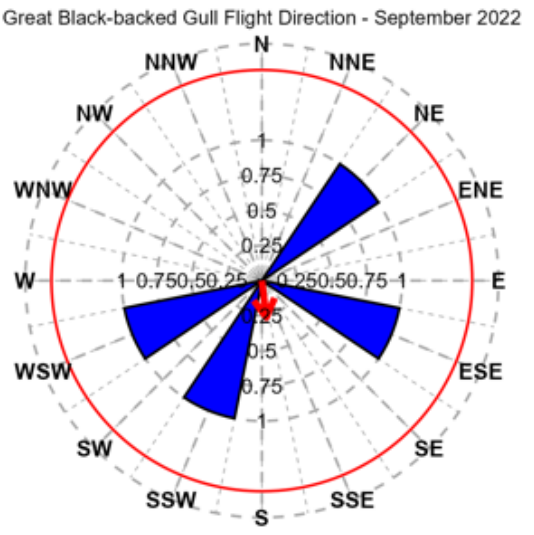

| | |
|---|---|
| Number of Observations | 25 |
| Mean Vector (μ) | 189.626 |
| Length of Mean Vector (r) | 0.105 |
| Rayleigh Test (Z) | 0.278 |
| Rayleigh Test (p) | 0.761 |

**a November 2021**



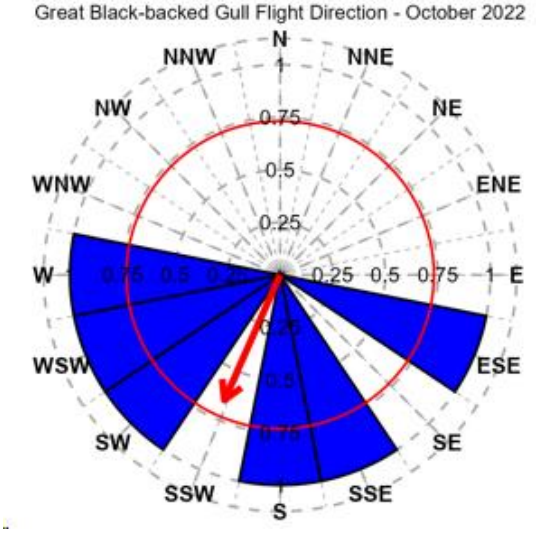

| | |
|---|---|
| Number of Observations | 2 |
| Mean Vector (μ) | 143.938 |
| Length of Mean Vector (r) | 0.989 |
| Rayleigh Test (Z) | 1.995 |
| Rayleigh Test (p) | 0.146 |

**b March 2022**



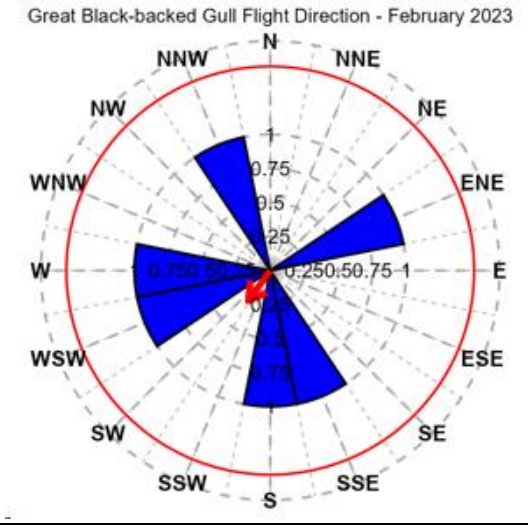

| | |
|---|---|
| Number of Observations | 4 |
| Mean Vector (μ) | 173.550 |
| Length of Mean Vector (r) | 0.264 |
| Rayleigh Test (Z) | 0.279 |
| Rayleigh Test (p) | 0.780 |

**c September 2022**



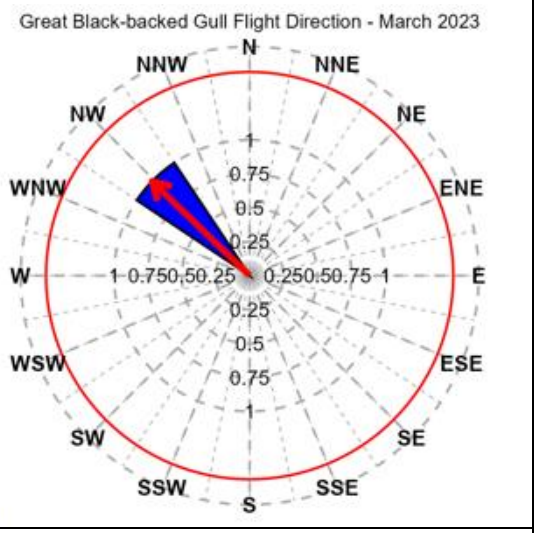

| | |
|---|---|
| Number of Observations | 6 |
| Mean Vector (μ) | 204.158 |
| Length of Mean Vector (r) | 0.652 |
| Rayleigh Test (Z) | 2.548 |
| Rayleigh Test (p) | 0.073 |

**d October 2022**




| | |
|---|---|
| Number of Observations | 6 |
| Mean Vector (μ) | 216.380 |
| Length of Mean Vector (r) | 0.276 |
| Rayleigh Test (Z) | 0.458 |
| Rayleigh Test (p) | 0.652 |

**e February 2023**

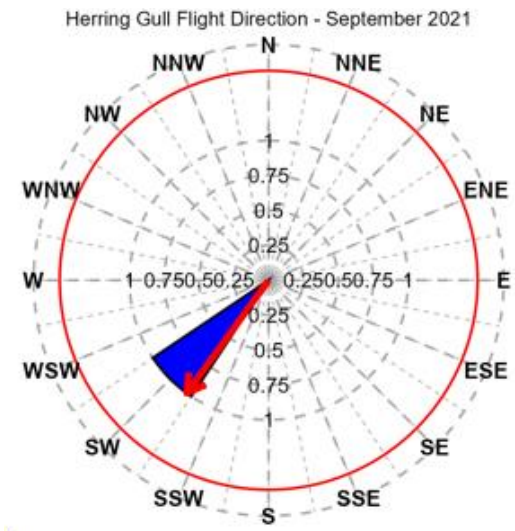



| | |
|---|---|
| Number of Observations | 1 |
| Mean Vector (μ) | 314.195 |
| Length of Mean Vector (r) | 1.000 |
| Rayleigh Test (Z) | 1.000 |
| Rayleigh Test (p) | 0.512 |

**f March 2023**

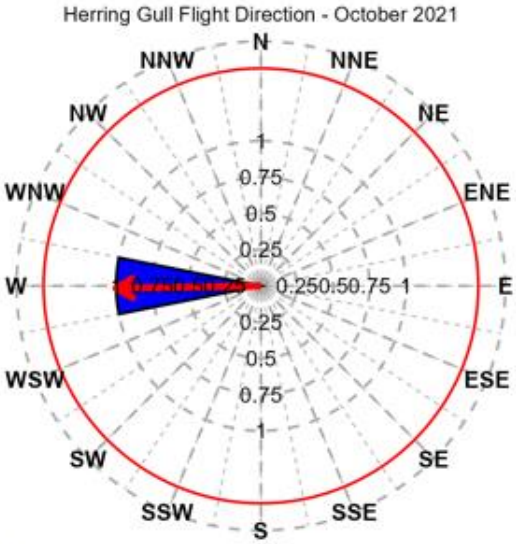
**Figure A5.438 Flight direction of great black-backed gulls during the survey period**

## Herring gull



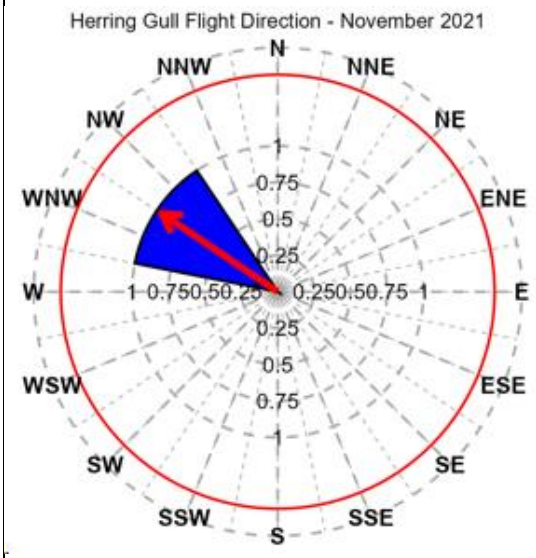

| | |
|---|---|
| Number of Observations | 1 |
| Mean Vector (μ) | 216.702 |
| Length of Mean Vector (r) | 1.000 |
| Rayleigh Test (Z) | 1.000 |
| Rayleigh Test (p) | 0.512 |

**a September 2021**



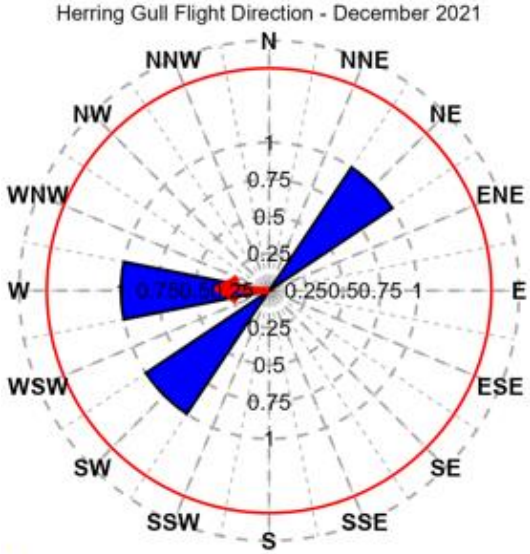

| | |
|---|---|
| Number of Observations | 1 |
| Mean Vector (μ) | 269.184 |
| Length of Mean Vector (r) | 1.000 |
| Rayleigh Test (Z) | 1.000 |
| Rayleigh Test (p) | 0.512 |

**b October 2021**



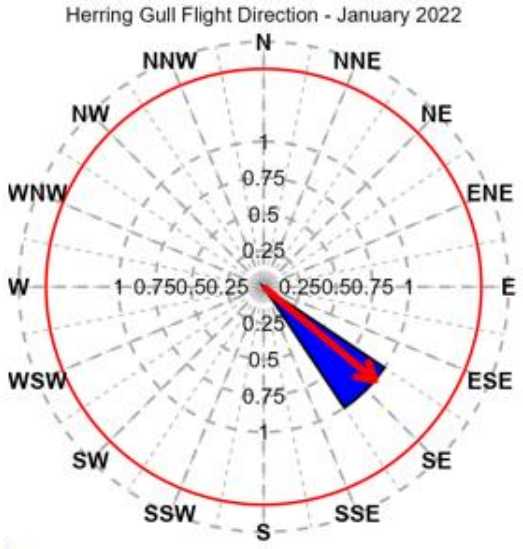

| | |
|---|---|
| Number of Observations | 2 |
| Mean Vector (μ) | 304.130 |
| Length of Mean Vector (r) | 0.961 |
| Rayleigh Test (Z) | 1.846 |
| Rayleigh Test (p) | 0.168 |

**c November 2021**



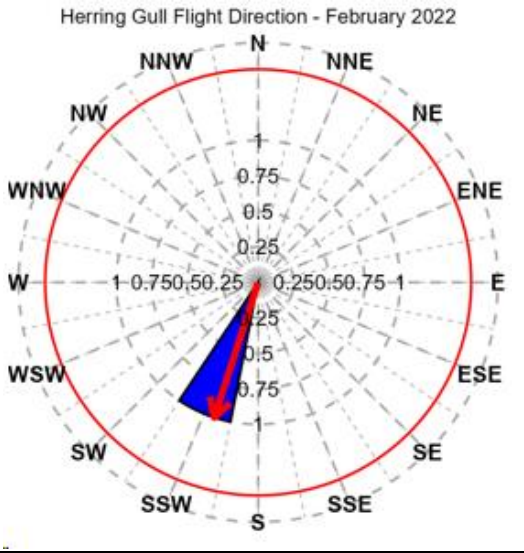

| | |
|---|---|
| Number of Observations | 3 |
| Mean Vector (μ) | 272.152 |
| Length of Mean Vector (r) | 0.343 |
| Rayleigh Test (Z) | 0.354 |
| Rayleigh Test (p) | 0.737 |

**d December 2021**



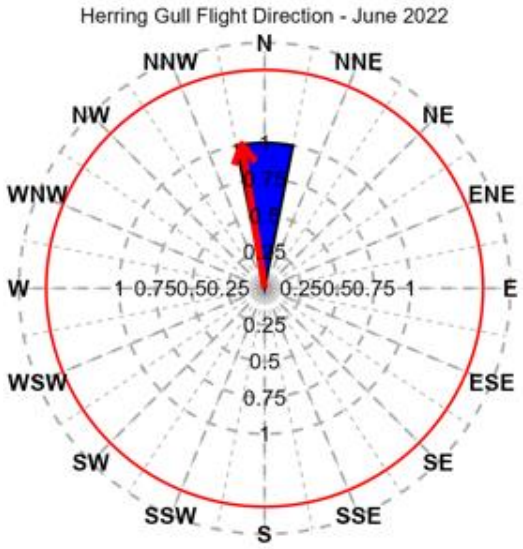

| | |
|---|---|
| Number of Observations | 1 |
| Mean Vector (μ) | 130.886 |
| Length of Mean Vector (r) | 1.000 |
| Rayleigh Test (Z) | 1.000 |
| Rayleigh Test (p) | 0.512 |

**e January 2022**



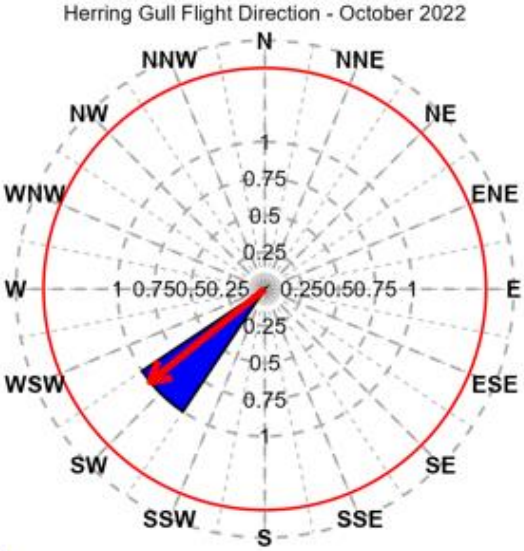

| | |
|---|---|
| Number of Observations | 1 |
| Mean Vector (μ) | 198.056 |
| Length of Mean Vector (r) | 1.000 |
| Rayleigh Test (Z) | 1.000 |
| Rayleigh Test (p) | 0.512 |

**f February 2022**



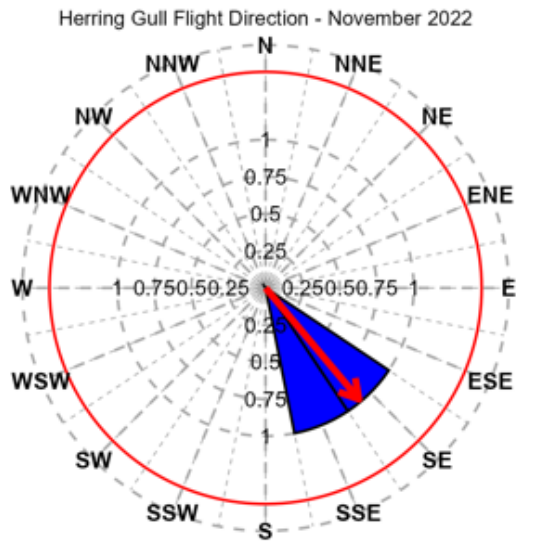

| | |
|---|---|
| Number of Observations | 1 |
| Mean Vector (μ) | 351.371 |
| Length of Mean Vector (r) | 1.000 |
| Rayleigh Test (Z) | 1.000 |
| Rayleigh Test (p) | 0.512 |

**g June 2022**

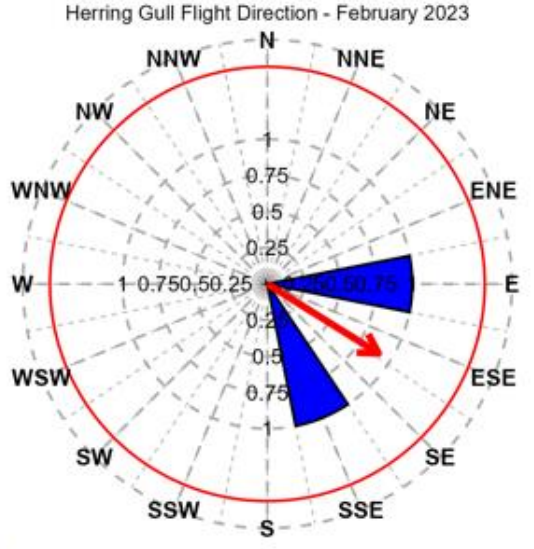



| | |
|---|---|
| Number of Observations | 1 |
| Mean Vector (μ) | 231.440 |
| Length of Mean Vector (r) | 1.000 |
| Rayleigh Test (Z) | 1.000 |
| Rayleigh Test (p) | 0.512 |

**h October 2022**



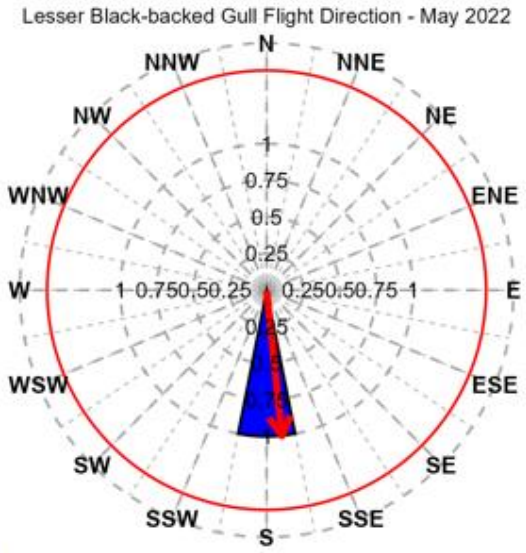

| | |
|---|---|
| Number of Observations | 2 |
| Mean Vector (μ) | 140.560 |
| Length of Mean Vector (r) | 0.981 |
| Rayleigh Test (Z) | 1.924 |
| Rayleigh Test (p) | 0.152 |
| **i November 2022** | |




| | |
|---|---|
| Number of Observations | 2 |
| Mean Vector (μ) | 122.846 |
| Length of Mean Vector (r) | 0.904 |
| Rayleigh Test (Z) | 1.634 |
| Rayleigh Test (p) | 0.217 |
| **j February 2023** | |

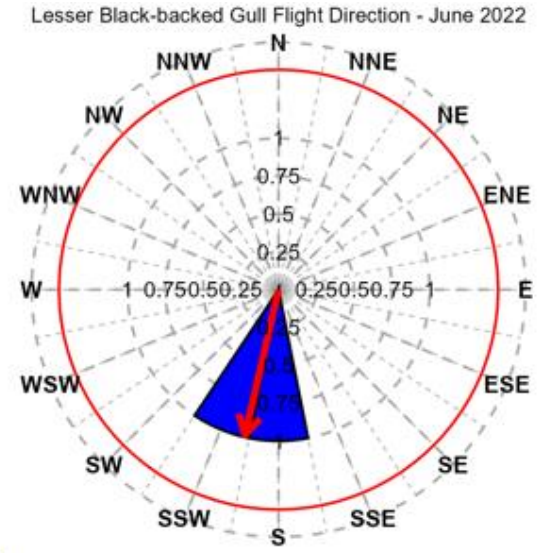
**Figure A5.439 Flight direction of herring gulls during the survey period**

## Lesser black-backed gull



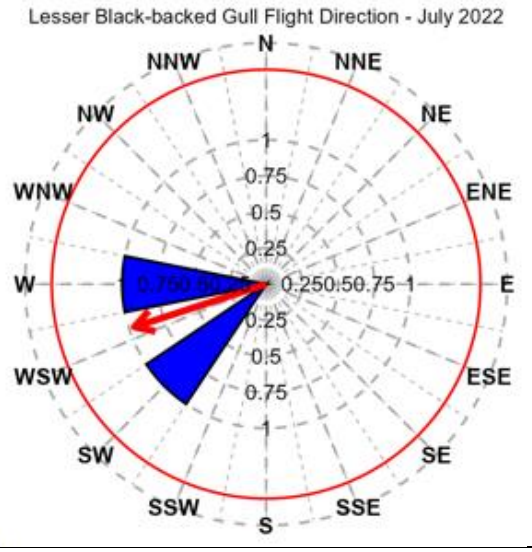

| | |
|---|---|
| Number of Observations | 1 |
| Mean Vector (μ) | 174.117 |
| Length of Mean Vector (r) | 1.000 |
| Rayleigh Test (Z) | 1.000 |
| Rayleigh Test (p) | 0.512 |

**a May 2022**




| | |
|---|---|
| Number of Observations | 2 |
| Mean Vector (μ) | 193.852 |
| Length of Mean Vector (r) | 0.985 |
| Rayleigh Test (Z) | 1.939 |
| Rayleigh Test (p) | 0.149 |

**b June 2022**

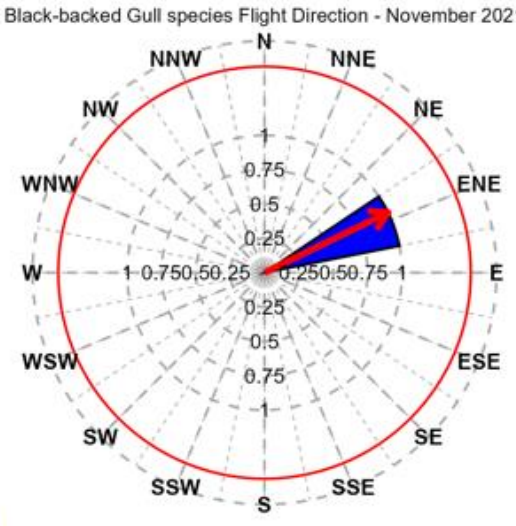



| | |
|---|---|
| Number of Observations | 2 |
| Mean Vector (μ) | 252.014 |
| Length of Mean Vector (r) | 0.961 |
| Rayleigh Test (Z) | 1.848 |
| Rayleigh Test (p) | 0.167 |

**c July 2022**

**Figure A5.440 Flight direction of lesser black-backed gulls during the survey period**

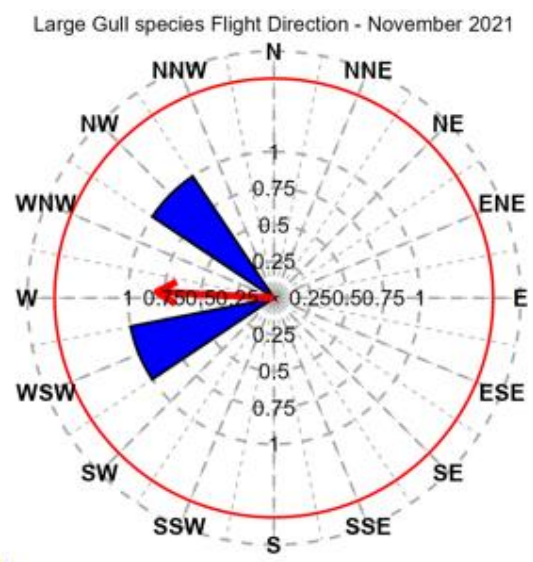
## Black-backed gull species



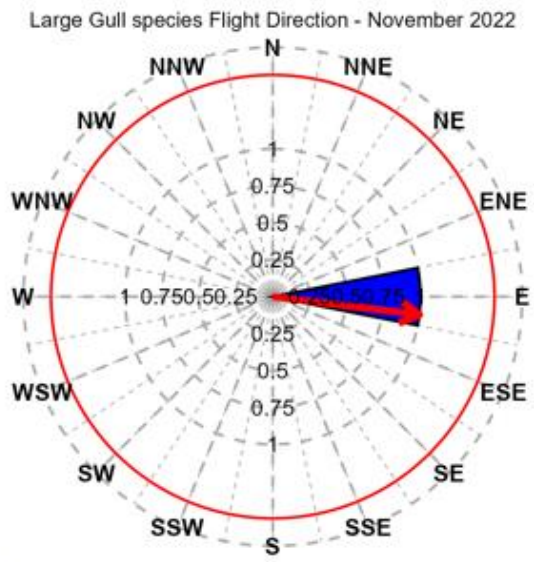

| | |
|---|---|
| Number of Observations | 1 |
| Mean Vector (μ) | 64.895 |
| Length of Mean Vector (r) | 1.000 |
| Rayleigh Test (Z) | 1.000 |
| Rayleigh Test (p) | 0.512 |
| **November 2021** | |

**Figure A5.441 Flight direction of black-backed gull species during the survey period**

## Unidentified large gull species



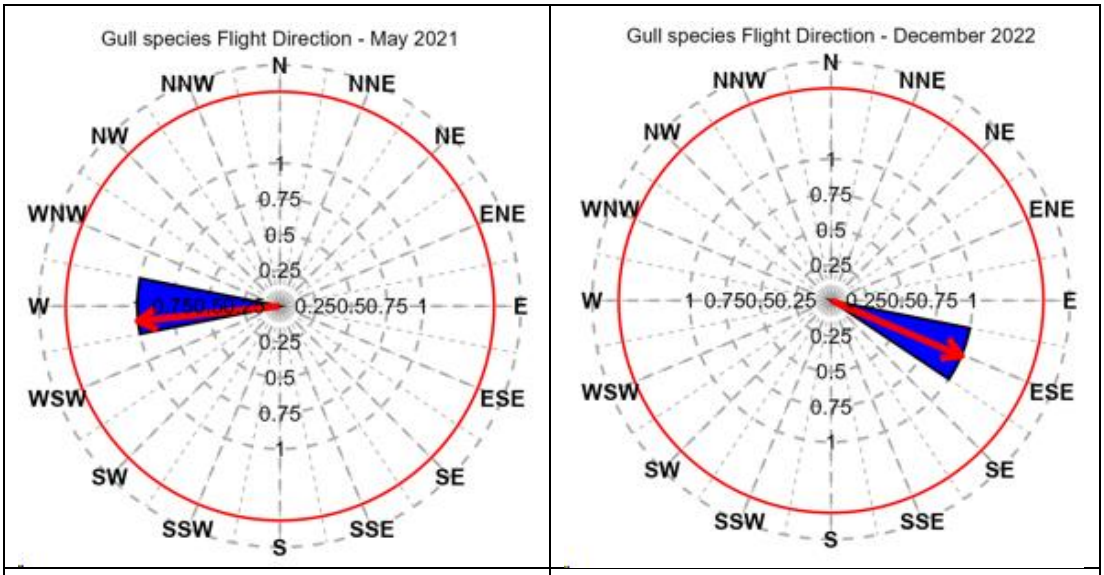

| | |
|---|---|
| Number of Observations | 2 |
| Mean Vector (μ) | 273.891 |
| Length of Mean Vector (r) | 0.801 |
| Rayleigh Test (Z) | 1.282 |
| Rayleigh Test (p) | 0.322 |
| **a November 2021** | |




| | |
|---|---|
| Number of Observations | 1 |
| Mean Vector (μ) | 97.595 |
| Length of Mean Vector (r) | 1.000 |
| Rayleigh Test (Z) | 1.000 |
| Rayleigh Test (p) | 0.512 |
| **b November 2022** | |

**Figure A5.442 Flight direction of large gull species during the survey period**

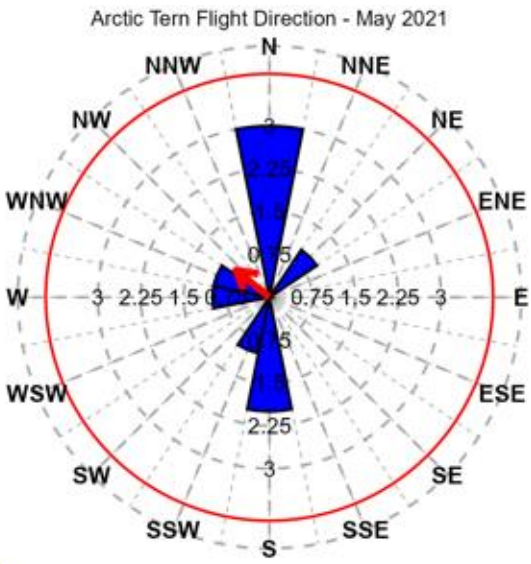
## Unidentified gull species




| | | | |
|---|---|---|---|
| Number of Observations | 1 | Number of Observations | 1 |
| Mean Vector (μ) | 264.922 | Mean Vector (μ) | 113.564 |
| Length of Mean Vector (r) | 1.000 | Length of Mean Vector (r) | 1.000 |
| Rayleigh Test (Z) | 1.000 | Rayleigh Test (Z) | 1.000 |
| Rayleigh Test (p) | 0.512 | Rayleigh Test (p) | 0.512 |
| **a May 2021** | | **b December 2022** | |

**Figure A5.443 Flight direction of gull species during the survey period**

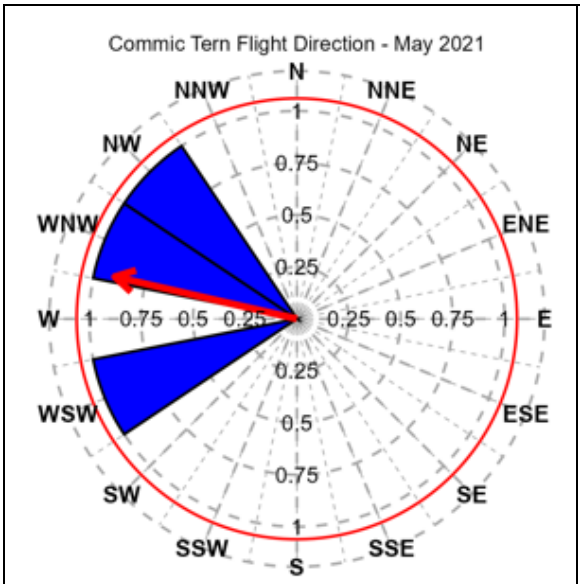
## Arctic tern




| | |
|---|---|
| Number of Observations | 9 |
| Mean Vector (μ) | 309.774 |
| Length of Mean Vector (r) | 0.251 |
| Rayleigh Test (Z) | 0.565 |
| Rayleigh Test (p) | 0.582 |
| **May 2021** | |

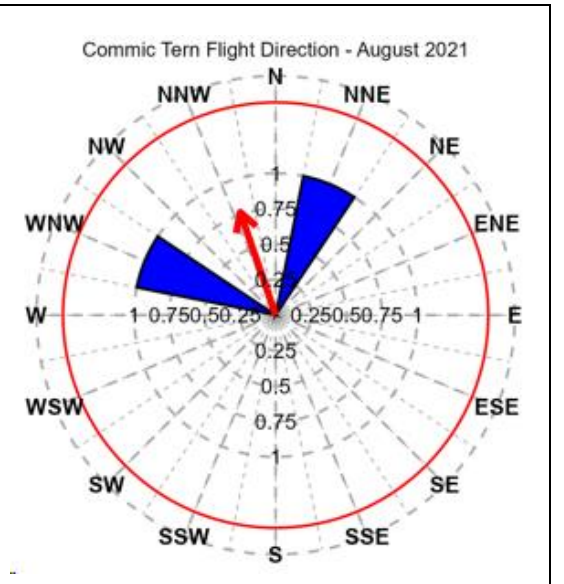
**Figure A5.444 Flight direction of Arctic terns during the survey period**

## 'Commic' tern



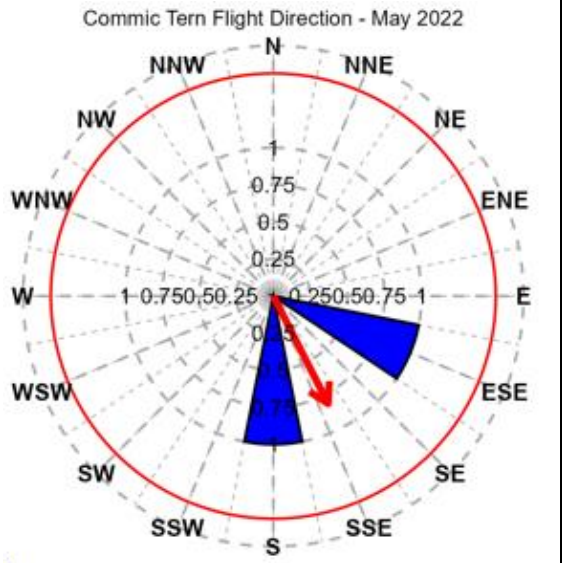

| | |
|---|---|
| Number of Observations | 3 |
| Mean Vector (μ) | 283.725 |
| Length of Mean Vector (r) | 0.899 |
| Rayleigh Test (Z) | 2.426 |
| Rayleigh Test (p) | 0.079 |

**a May 2021**



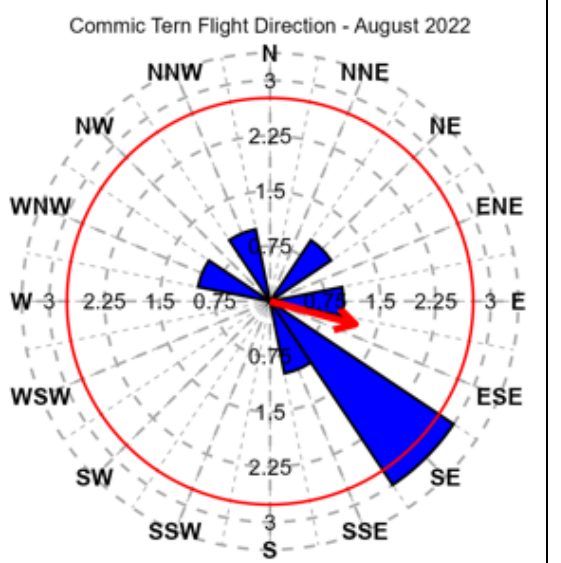

| | |
|---|---|
| Number of Observations | 2 |
| Mean Vector (μ) | 341.460 |
| Length of Mean Vector (r) | 0.767 |
| Rayleigh Test (Z) | 1.177 |
| Rayleigh Test (p) | 0.358 |

**b August 2021**




| | |
|---|---|
| Number of Observations | 2 |
| Mean Vector (μ) | 153.744 |
| Length of Mean Vector (r) | 0.814 |
| Rayleigh Test (Z) | 1.325 |
| Rayleigh Test (p) | 0.307 |

**c May 2022**

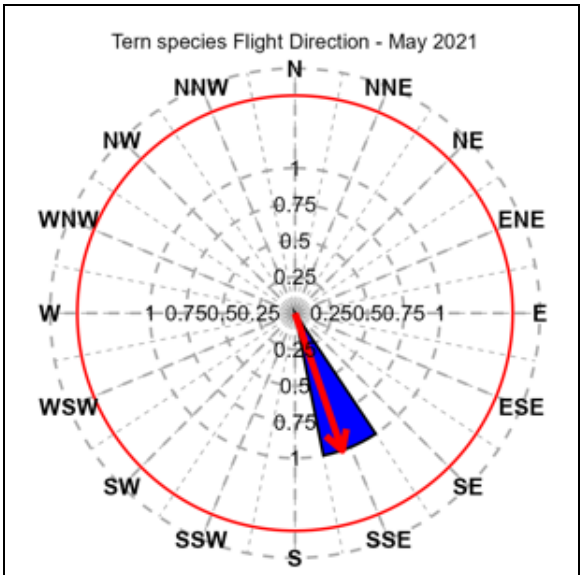



| | |
|---|---|
| Number of Observations | 8 |
| Mean Vector (μ) | 105.622 |
| Length of Mean Vector (r) | 0.399 |
| Rayleigh Test (Z) | 1.276 |
| Rayleigh Test (p) | 0.288 |

**d August 2022**

**Figure A5.445 Flight direction of 'commic' terns during the survey period**

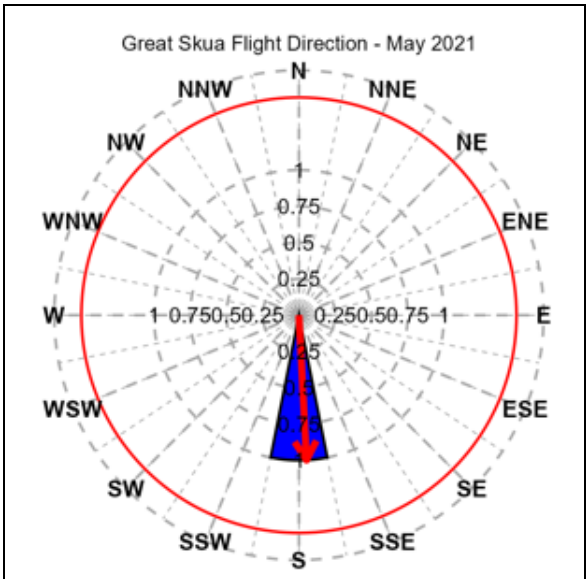
## Unidentified tern species




| | |
|---|---|
| Number of Observations | 1 |
| Mean Vector (μ) | 161.193 |
| Length of Mean Vector (r) | 1.000 |
| Rayleigh Test (Z) | 1.000 |
| Rayleigh Test (p) | 0.512 |
| **May 2021** | |

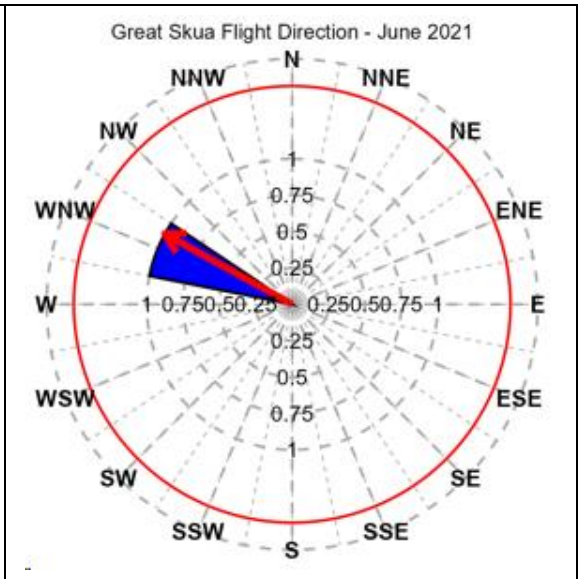
**Figure A5.446 Flight direction of tern species during the survey period**

## Great skua



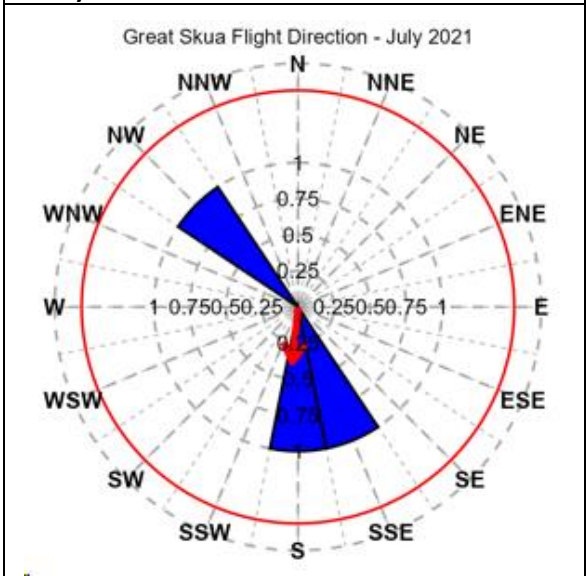

| | |
|---|---|
| Number of Observations | 1 |
| Mean Vector (μ) | 177.119 |
| Length of Mean Vector (r) | 1.000 |
| Rayleigh Test (Z) | 1.000 |
| Rayleigh Test (p) | 0.512 |

**a May 2021**



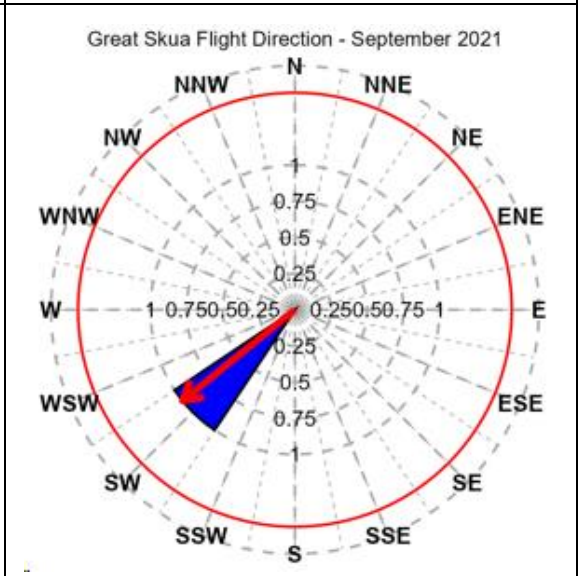

| | |
|---|---|
| Number of Observations | 1 |
| Mean Vector (μ) | 299.891 |
| Length of Mean Vector (r) | 1.000 |
| Rayleigh Test (Z) | 1.000 |
| Rayleigh Test (p) | 0.512 |

**b June 2021**



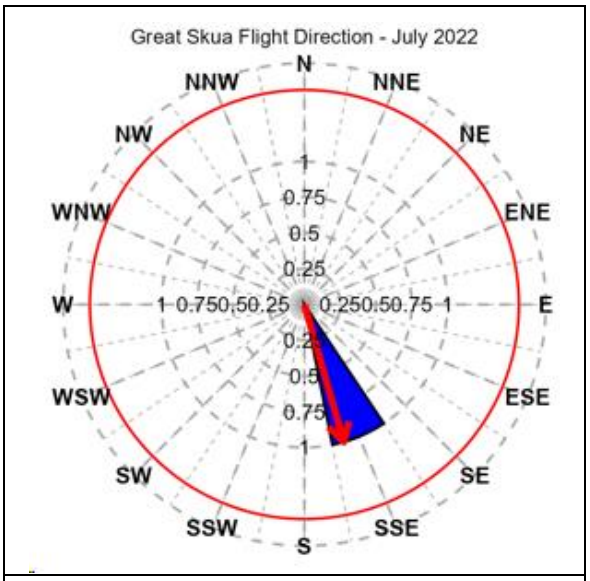

| | |
|---|---|
| Number of Observations | 3 |
| Mean Vector (μ) | 186.812 |
| Length of Mean Vector (r) | 0.383 |
| Rayleigh Test (Z) | 0.440 |
| Rayleigh Test (p) | 0.683 |

**c July 2021**




| | |
|---|---|
| Number of Observations | 1 |
| Mean Vector (μ) | 231.099 |
| Length of Mean Vector (r) | 1.000 |
| Rayleigh Test (Z) | 1.000 |
| Rayleigh Test (p) | 0.512 |

**d September 2021**

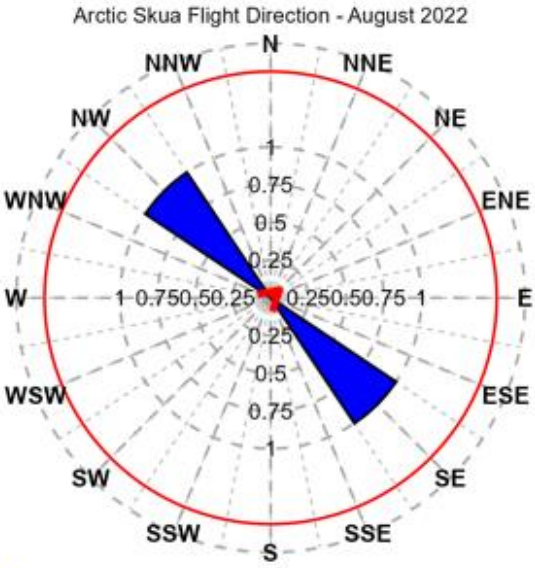



| | |
|---|---|
| Number of Observations | 1 |
| Mean Vector (μ) | 164.806 |
| Length of Mean Vector (r) | 1.000 |
| Rayleigh Test (Z) | 1.000 |
| Rayleigh Test (p) | 0.512 |

**e July 2022**

**Figure A5.447 Flight direction of great skuas during the survey period**

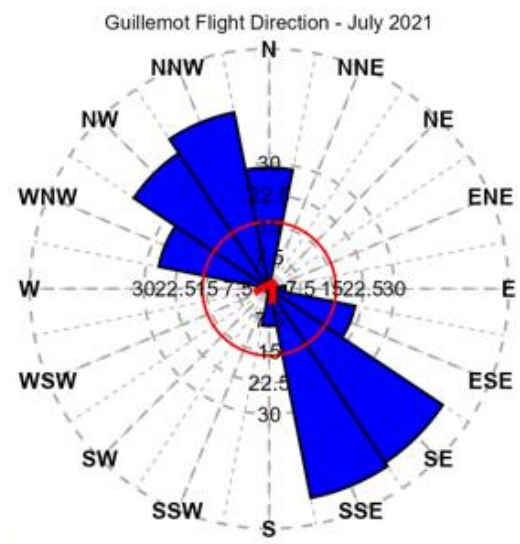
## Artic skua




| | |
|---|---|
| Number of Observations | 2 |
| Mean Vector (μ) | 48.748 |
| Length of Mean Vector (r) | 0.079 |
| Rayleigh Test (Z) | 0.012 |
| Rayleigh Test (p) | 0.991 |
| **August 2022** | |

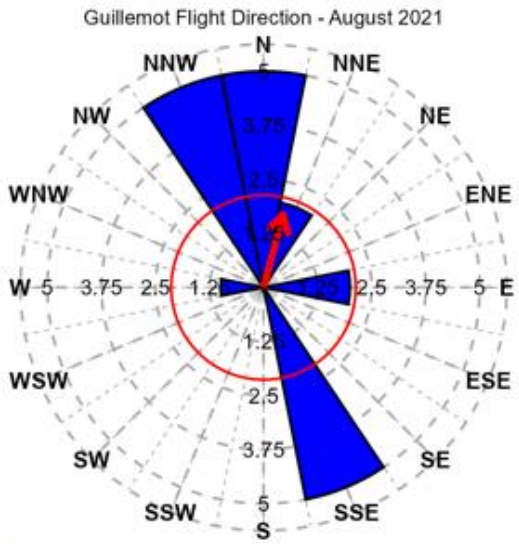
**Figure A5.448 Flight direction of Arctic skuas during the survey period**

## Guillemot



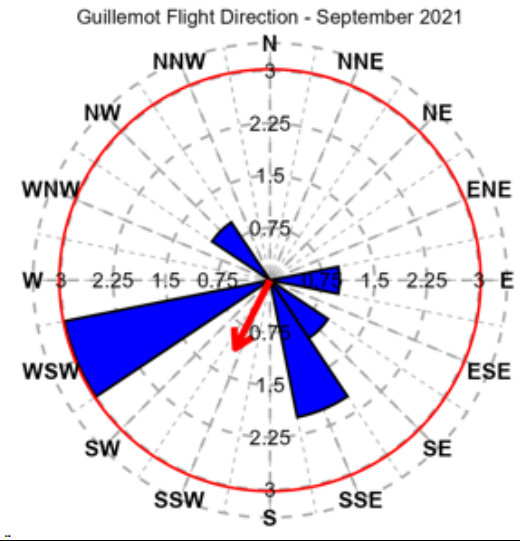

| | |
|---|---|
| Number of Observations | 282 |
| Mean Vector (μ) | 27.189 |
| Length of Mean Vector (r) | 0.035 |
| Rayleigh Test (Z) | 0.348 |
| Rayleigh Test (p) | 0.706 |

**a July 2021**



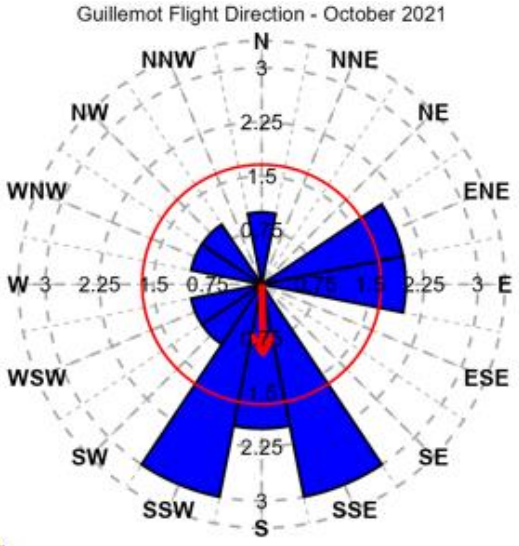

| | |
|---|---|
| Number of Observations | 20 |
| Mean Vector (μ) | 15.040 |
| Length of Mean Vector (r) | 0.349 |
| Rayleigh Test (Z) | 2.436 |
| Rayleigh Test (p) | 0.086 |

**b August 2021**



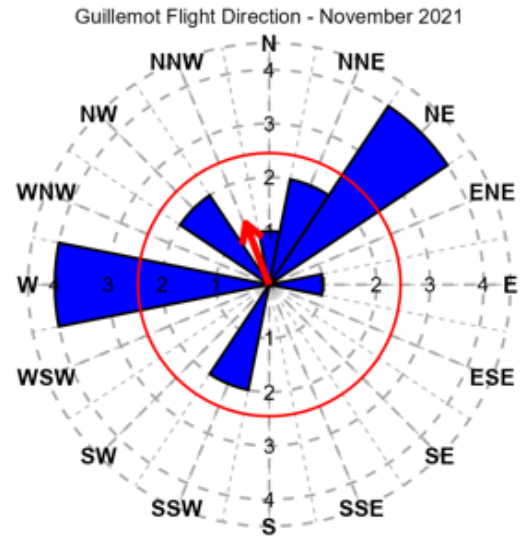

| | |
|---|---|
| Number of Observations | 8 |
| Mean Vector (μ) | 207.633 |
| Length of Mean Vector (r) | 0.365 |
| Rayleigh Test (Z) | 1.066 |
| Rayleigh Test (p) | 0.356 |

**c September 2021**



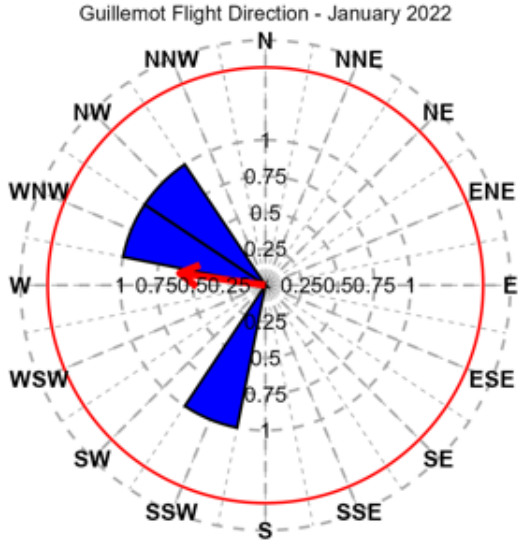

| | |
|---|---|
| Number of Observations | 17 |
| Mean Vector (μ) | 179.999 |
| Length Mean Vector (r) | 0.317 |
| Rayleigh Test (Z) | 1.710 |
| Rayleigh Test (p) | 0.182 |

**d October 2021**



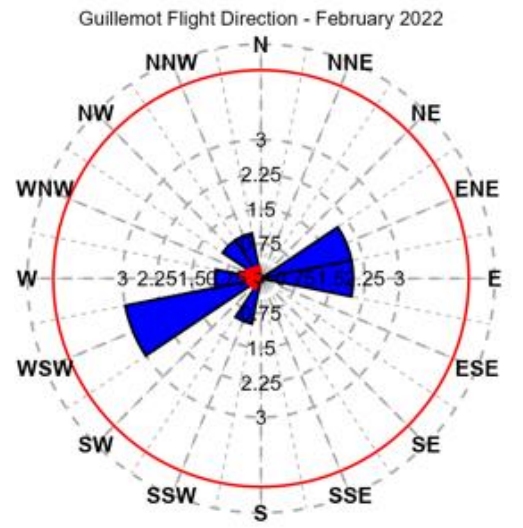

| | |
|---|---|
| Number of Observations | 16 |
| Mean Vector (μ) | 339.394 |
| Length of Mean Vector (r) | 0.305 |
| Rayleigh Test (Z) | 1.490 |
| Rayleigh Test (p) | 0.228 |

**e November 2021**



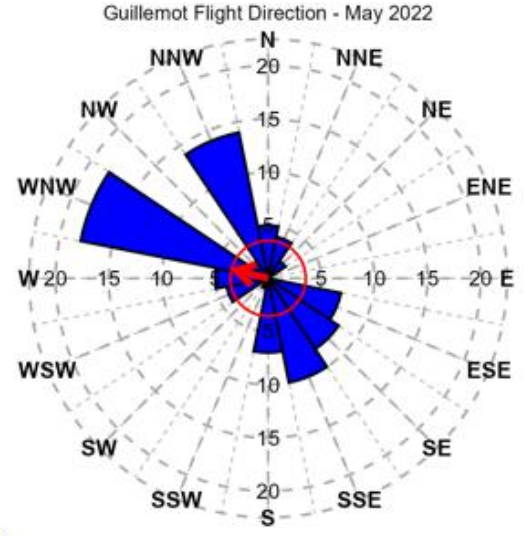

| | |
|---|---|
| Number of Observations | 3 |
| Mean Vector (μ) | 278.407 |
| Length of Mean Vector (r) | 0.597 |
| Rayleigh Test (Z) | 1.068 |
| Rayleigh Test (p) | 0.378 |

**f January 2022**



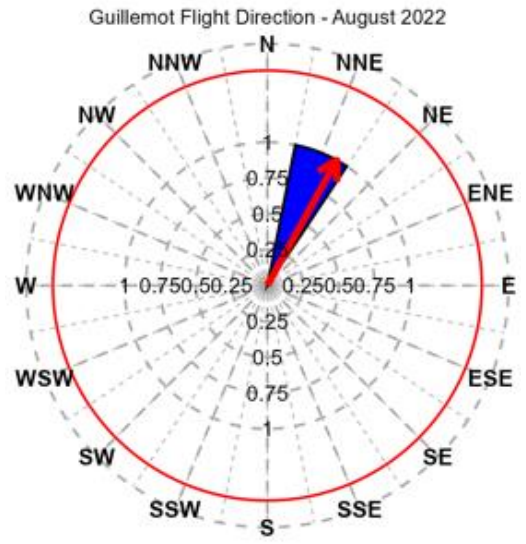

| | |
|---|---|
| Number of Observations | 11 |
| Mean Vector (μ) | 282.578 |
| Length of Mean Vector (r) | 0.144 |
| Rayleigh Test (Z) | 0.229 |
| Rayleigh Test (p) | 0.803 |

**g February 2022**



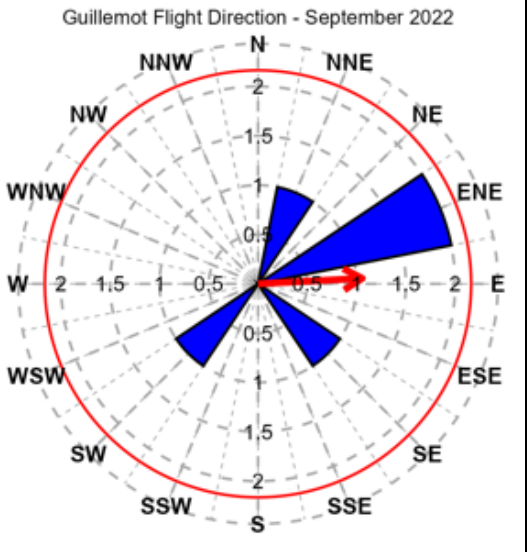

| | |
|---|---|
| Number of Observations | 87 |
| Mean Vector (μ) | 284.052 |
| Length of Mean Vector (r) | 0.174 |
| Rayleigh Test (Z) | 2.627 |
| Rayleigh Test (p) | 0.072 |

**h May 2022**




| | |
|---|---|
| Number of Observations | 1 |
| Mean Vector (μ) | 29.346 |
| Length of Mean Vector (r) | 1.000 |
| Rayleigh Test (Z) | 1.000 |
| Rayleigh Test (p) | 0.512 |

**i August 2022**



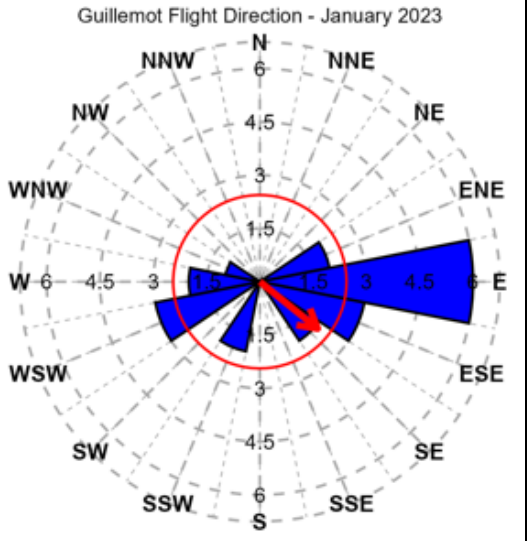

| | |
|---|---|
| Number of Observations | 5 |
| Mean Vector (μ) | 87.235 |
| Length of Mean Vector (r) | 0.529 |
| Rayleigh Test (Z) | 1.398 |
| Rayleigh Test (p) | 0.259 |

**j September 2022**



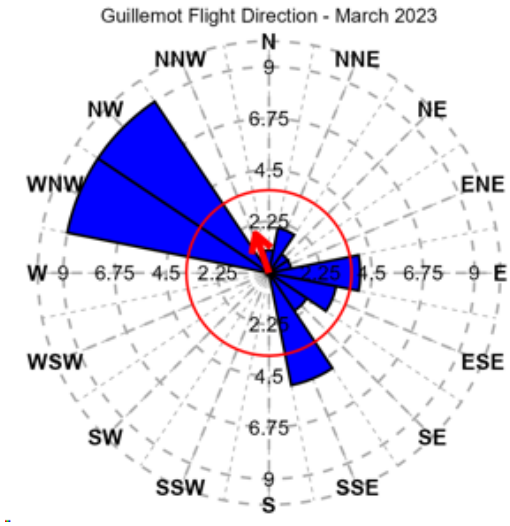

| | |
|---|---|
| Number of Observations | 2 |
| Mean Vector (μ) | 49.300 |
| Length of Mean Vector (r) | 0.247 |
| Rayleigh Test (Z) | 0.122 |
| Rayleigh Test (p) | 0.910 |

**k November 2022**

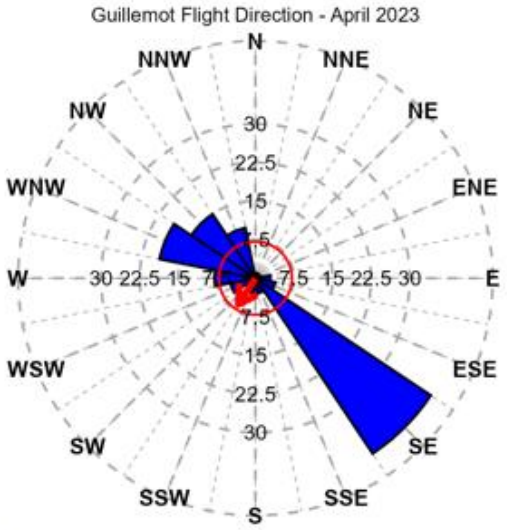



| | |
|---|---|
| Number of Observations | 21 |
| Mean Vector (μ) | 129.092 |
| Length of Mean Vector (r) | 0.349 |
| Rayleigh Test (Z) | 2.557 |
| Rayleigh Test (p) | 0.076 |

**l January 2023**



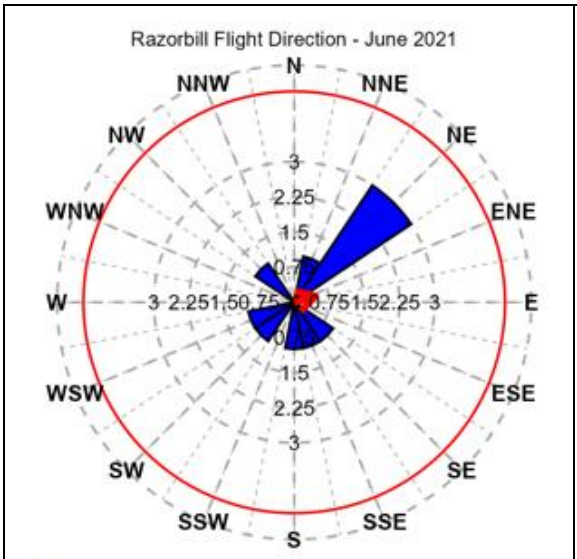

| | |
|---|---|
| Number of Observations | 37 |
| Mean Vector (μ) | 341.517 |
| Length of Mean Vector (r) | 0.201 |
| Rayleigh Test (Z) | 1.488 |
| Rayleigh Test (p) | 0.227 |
| **m March 2023** | |




| | |
|---|---|
| Number of Observations | 116 |
| Mean Vector (μ) | 213.427 |
| Length of Mean Vector (r) | 0.148 |
| Rayleigh Test (Z) | 2.557 |
| Rayleigh Test (p) | 0.078 |
| **n April 2023** | |

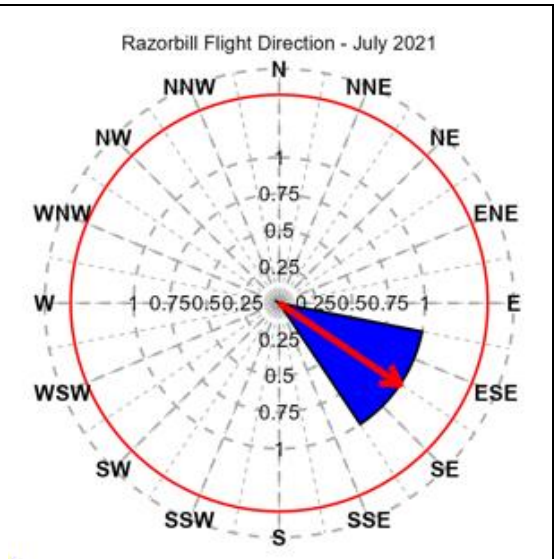
**Figure A5.449 Flight direction of guillemots during the survey period**

## Razorbill



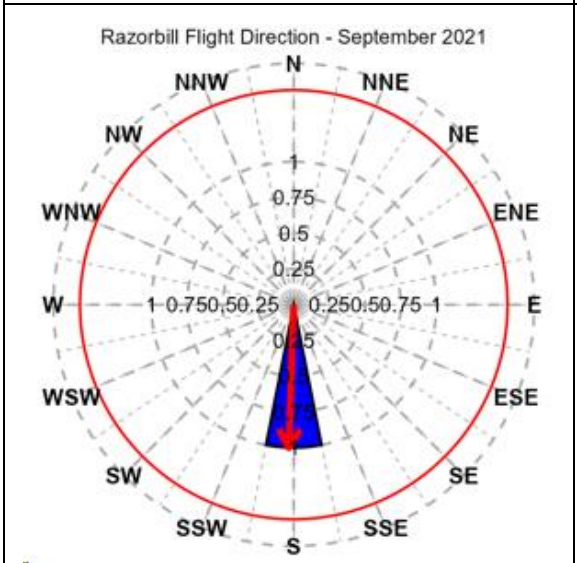

| | |
|---|---|
| Number of Observations | 10 |
| Mean Vector (μ) | 74.904 |
| Length of Mean Vector (r) | 0.157 |
| Rayleigh Test (Z) | 0.248 |
| Rayleigh Test (p) | 0.789 |

**a June 2021**



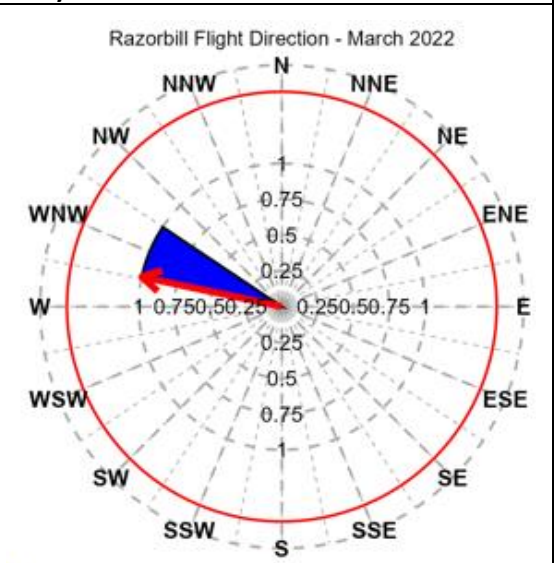

| | |
|---|---|
| Number of Observations | 2 |
| Mean Vector (μ) | 124.390 |
| Length of Mean Vector (r) | 1.000 |
| Rayleigh Test (Z) | 1.998 |
| Rayleigh Test (p) | 0.138 |

**b July 2021**



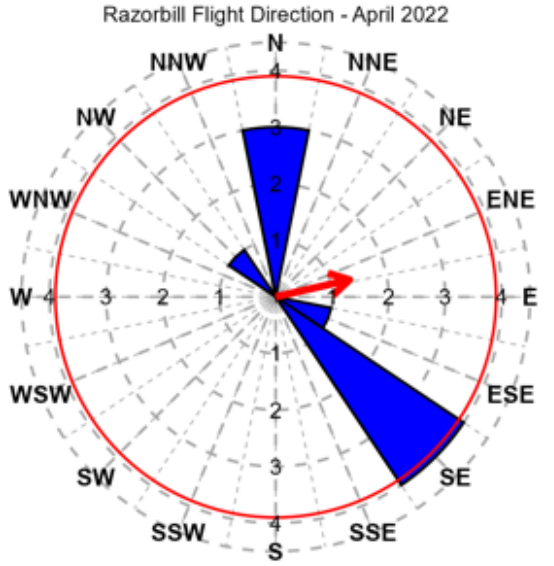

| | |
|---|---|
| Number of Observations | 1 |
| Mean Vector (μ) | 182.028 |
| Length of Mean Vector (r) | 1.000 |
| Rayleigh Test (Z) | 1.000 |
| Rayleigh Test (p) | 0.512 |

**c September 2021**



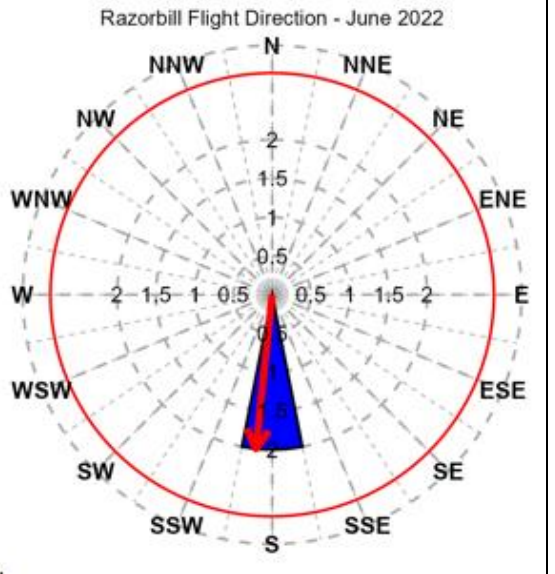

| | |
|---|---|
| Number of Observations | 1 |
| Mean Vector (μ) | 282.277 |
| Length of Mean Vector (r) | 1.000 |
| Rayleigh Test (Z) | 1.000 |
| Rayleigh Test (p) | 0.512 |

**d March 2022**



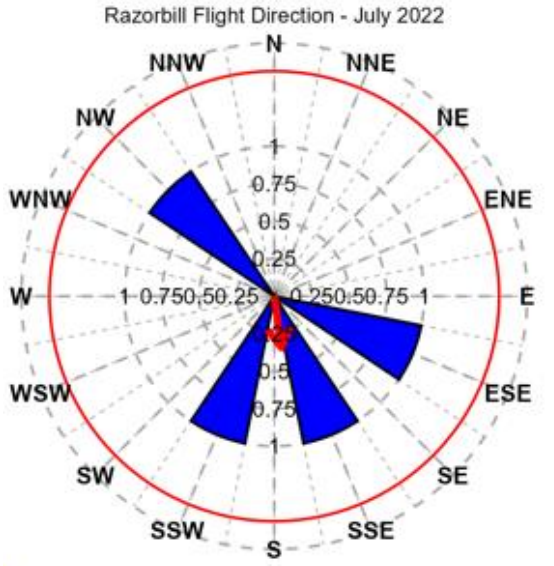

| | |
|---|---|
| Number of Observations | 9 |
| Mean Vector (μ) | 77.947 |
| Length of Mean Vector (r) | 0.335 |
| Rayleigh Test (Z) | 1.010 |
| Rayleigh Test (p) | 0.375 |

**e April 2022**



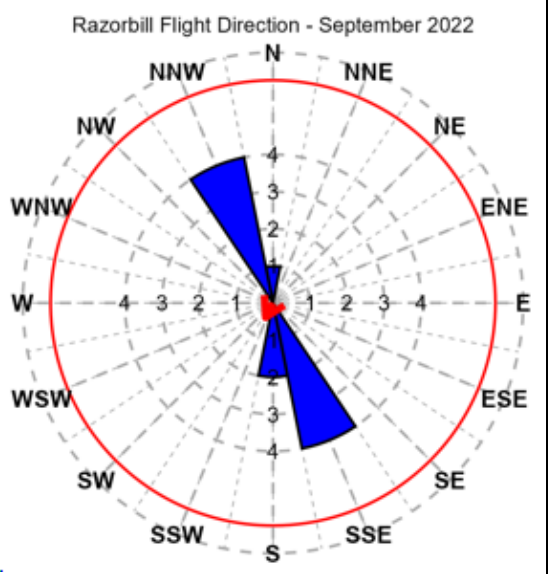

| | |
|---|---|
| Number of Observations | 2 |
| Mean Vector (μ) | 186.893 |
| Length of Mean Vector (r) | 1.000 |
| Rayleigh Test (Z) | 1.999 |
| Rayleigh Test (p) | 0.127 |

**f June 2022**



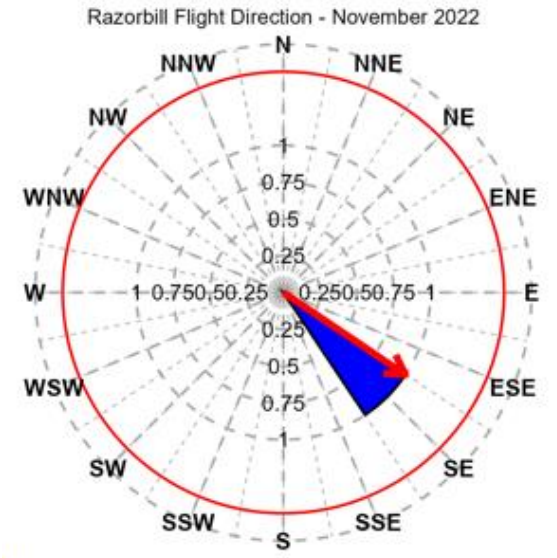

| | |
|---|---|
| Number of Observations | 4 |
| Mean Vector (μ) | 172.231 |
| Length of Mean Vector (r) | 0.347 |
| Rayleigh Test (Z) | 0.480 |
| Rayleigh Test (p) | 0.648 |

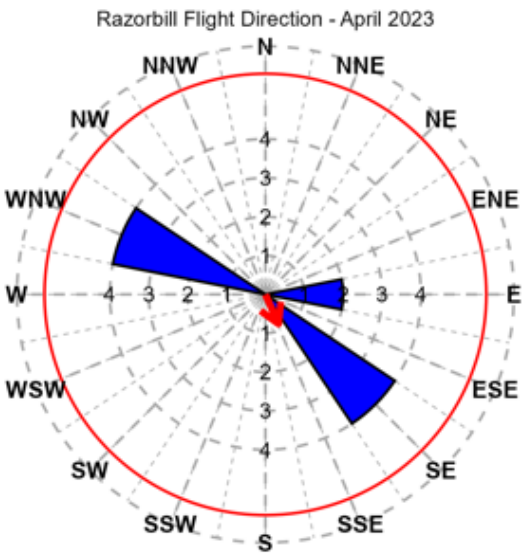
**g July 2022**




| | |
|---|---|
| Number of Observations | 11 |
| Mean Vector (μ) | 207.993 |
| Length of Mean Vector (r) | 0.111 |
| Rayleigh Test (Z) | 0.134 |
| Rayleigh Test (p) | 0.879 |

**h September 2022**

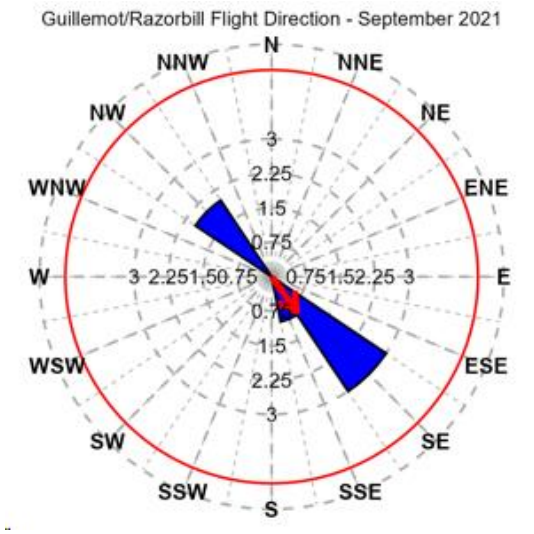



| | | | |
|---|---|---|---|
| Number of Observations | 1 | Number of Observations | 10 |
| Mean Vector (μ) | 124.396 | Mean Vector (μ) | 156.623 |
| Length of Mean Vector (r) | 1.000 | Length of Mean Vector (r) | 0.207 |
| Rayleigh Test (Z) | 1.000 | Rayleigh Test (Z) | 0.429 |
| Rayleigh Test (p) | 0.512 | Rayleigh Test (p) | 0.663 |
| **i November 2022** | | **j April 2023** | |

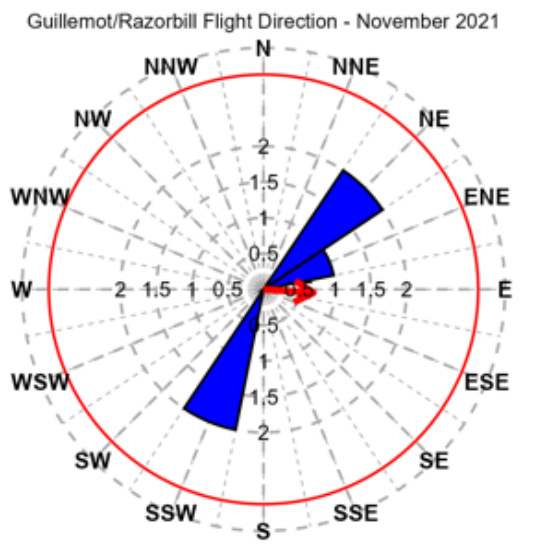
**Figure A5.450 Flight direction of razorbills during the survey period**

## Unidentified guillemot / razorbill



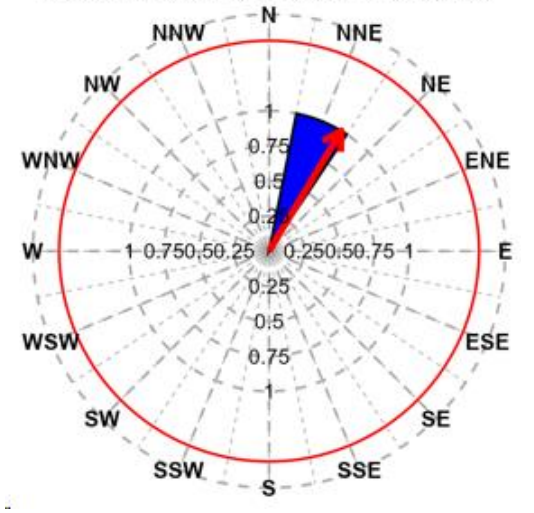

| | |
|---|---|
| Number of Observations | 6 |
| Mean Vector (μ) | 144.993 |
| Length of Mean Vector (r) | 0.311 |
| Rayleigh Test (Z) | 0.579 |
| Rayleigh Test (p) | 0.581 |

**a September 2021**



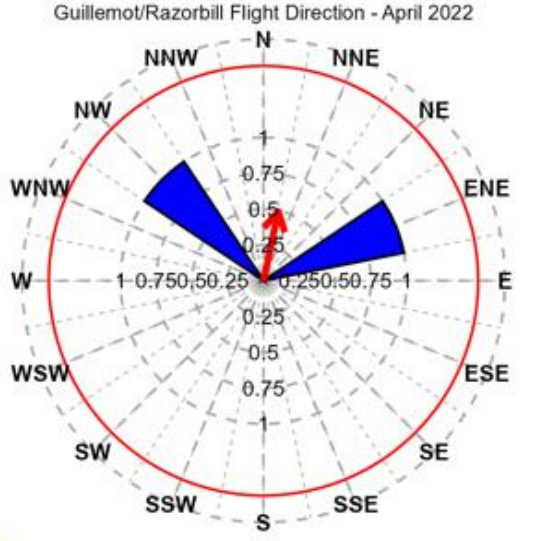

| | |
|---|---|
| Number of Observations | 5 |
| Mean Vector (μ) | 94.959 |
| Length of Mean Vector (r) | 0.347 |
| Rayleigh Test (Z) | 0.604 |
| Rayleigh Test (p) | 0.571 |

**b November 2021**



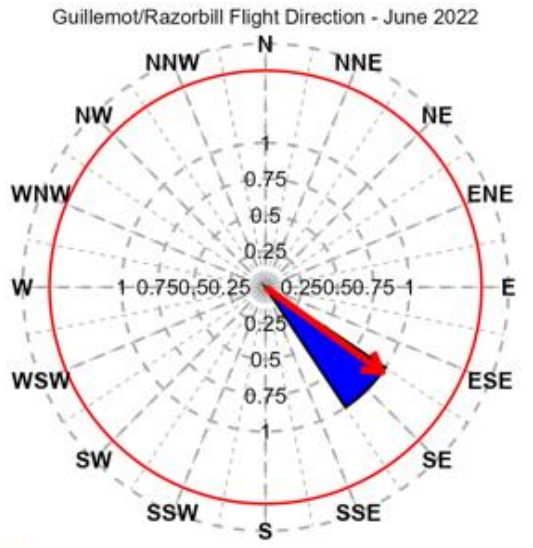

| | |
|---|---|
| Number of Observations | 1 |
| Mean Vector (μ) | 31.239 |
| Length of Mean Vector (r) | 1.000 |
| Rayleigh Test (Z) | 1.000 |
| Rayleigh Test (p) | 0.512 |

**c February 2022**



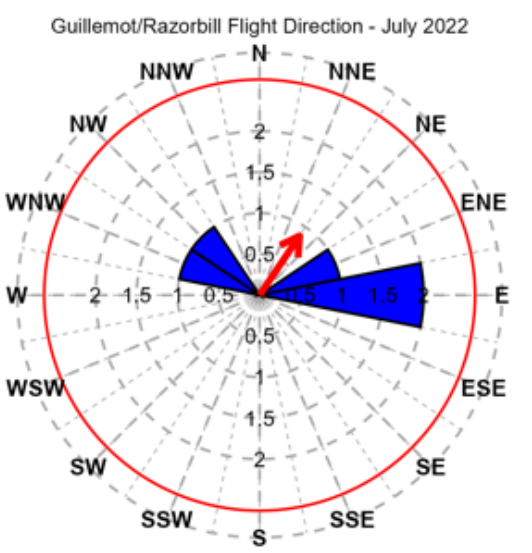

| | |
|---|---|
| Number of Observations | 2 |
| Mean Vector (μ) | 12.010 |
| Length Mean Vector (r) | 0.493 |
| Rayleigh Test (Z) | 0.486 |
| Rayleigh Test (p) | 0.678 |

**d April 2022**



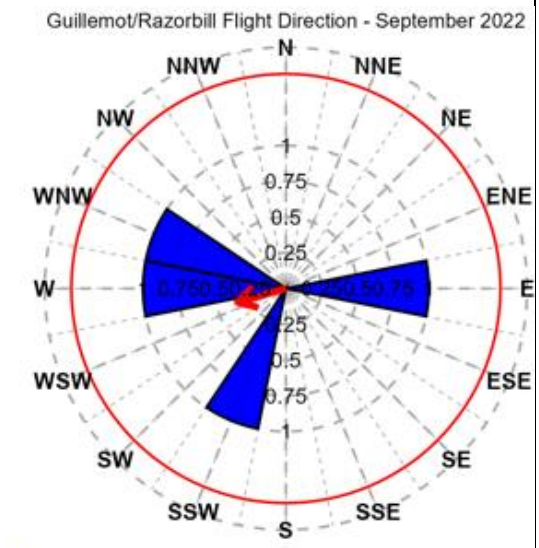

| | |
|---|---|
| Number of Observations | 1 |
| Mean Vector (μ) | 126.891 |
| Length of Mean Vector (r) | 1.000 |
| Rayleigh Test (Z) | 1.000 |
| Rayleigh Test (p) | 0.512 |

**e June 2022**



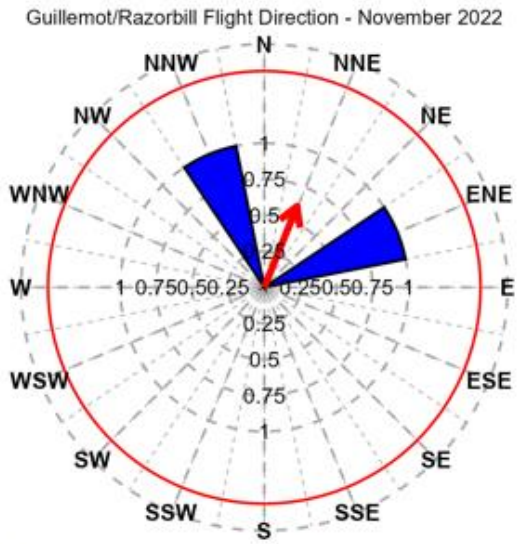

| | |
|---|---|
| Number of Observations | 5 |
| Mean Vector (μ) | 34.587 |
| Length of Mean Vector (r) | 0.435 |
| Rayleigh Test (Z) | 0.948 |
| Rayleigh Test (p) | 0.409 |

**f July 2022**



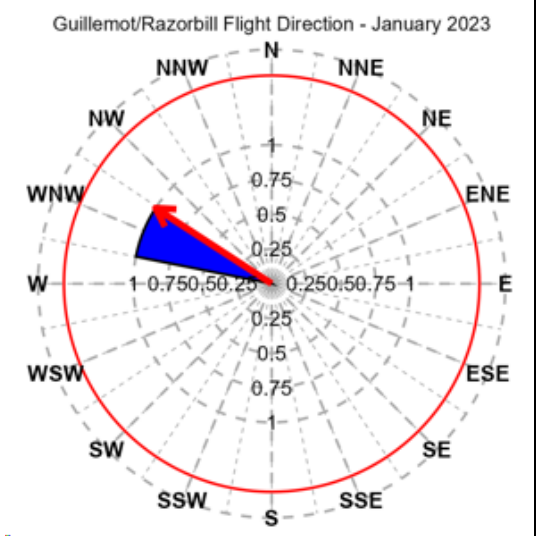

| | |
|---|---|
| Number of Observations | 4 |
| Mean Vector (μ) | 254.556 |
| Length of Mean Vector (r) | 0.351 |
| Rayleigh Test (Z) | 0.494 |
| Rayleigh Test (p) | 0.640 |

**g September 2022**



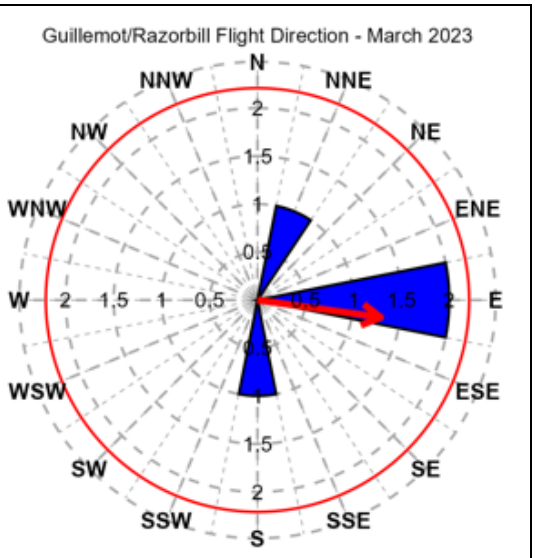

| | |
|---|---|
| Number of Observations | 2 |
| Mean Vector (μ) | 22.000 |
| Length of Mean Vector (r) | 0.606 |
| Rayleigh Test (Z) | 0.735 |
| Rayleigh Test (p) | 0.546 |

**h November 2022**



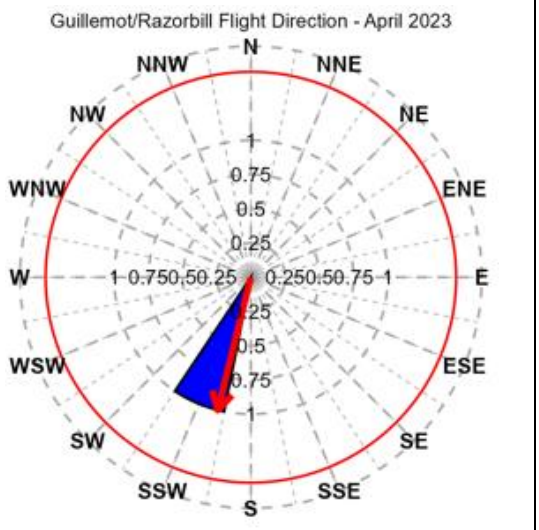

| | |
|---|---|
| Number of Observations | 1 |
| Mean Vector (μ) | 303.412 |
| Length of Mean Vector (r) | 1.000 |
| Rayleigh Test (Z) | 1.000 |
| Rayleigh Test (p) | 0.512 |

**i January 2023**




| | |
|---|---|
| Number of Observations | 4 |
| Mean Vector (μ) | 98.762 |
| Length of Mean Vector (r) | 0.648 |
| Rayleigh Test (Z) | 1.678 |
| Rayleigh Test (p) | 0.195 |

**j March 2023**

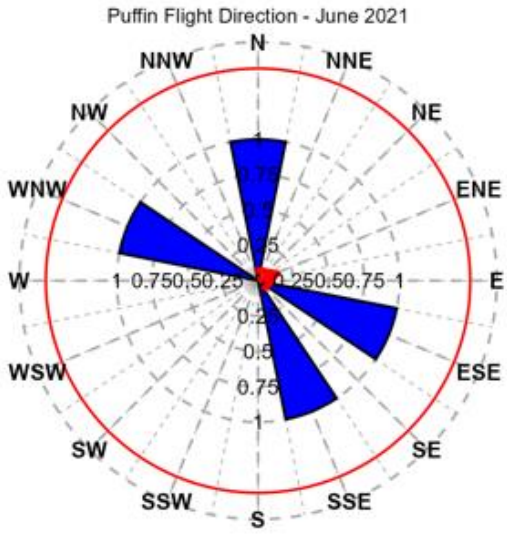



| | |
|---|---|
| Number of Observations | 1 |
| Mean Vector (μ) | 194.116 |
| Length of Mean Vector (r) | 1.000 |
| Rayleigh Test (Z) | 1.000 |
| Rayleigh Test (p) | 0.512 |

**k April 2023**

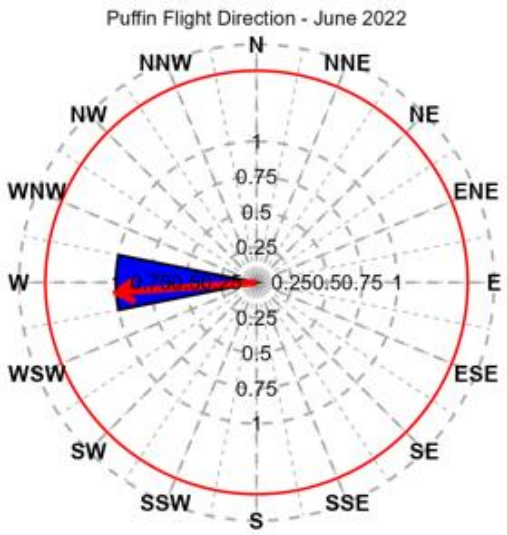
**Figure A5.451 Flight direction of guillemots / razorbills during the survey period**

## Puffin



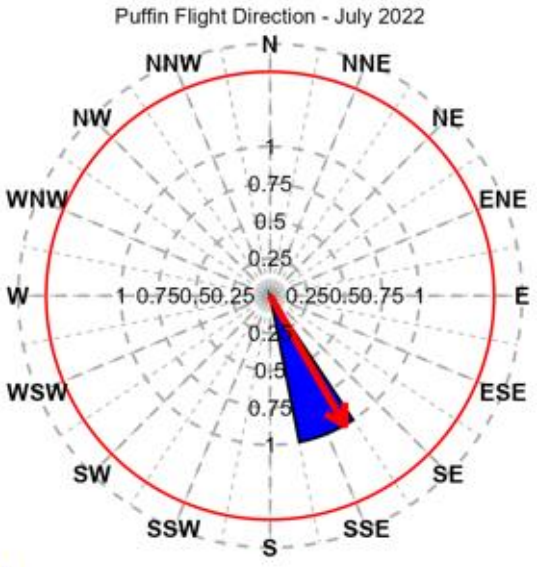

| | |
|---|---|
| Number of Observations | 4 |
| Mean Vector (μ) | 69.758 |
| Length of Mean Vector (r) | 0.143 |
| Rayleigh Test (Z) | 0.081 |
| Rayleigh Test (p) | 0.931 |

**a June 2021**




| | |
|---|---|
| Number of Observations | 1 |
| Mean Vector (μ) | 266.650 |
| Length of Mean Vector (r) | 1.000 |
| Rayleigh Test (Z) | 1.000 |
| Rayleigh Test (p) | 0.512 |

**b June 2022**

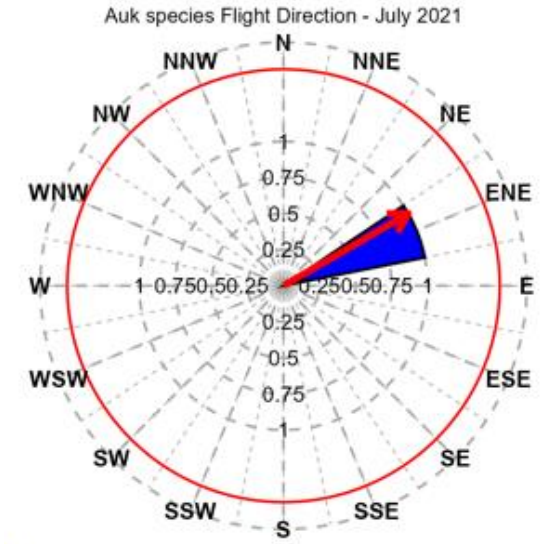



| | |
|---|---|
| Number of Observations | 1 |
| Mean Vector (μ) | 150.955 |
| Length of Mean Vector (r) | 1.000 |
| Rayleigh Test (Z) | 1.000 |
| Rayleigh Test (p) | 0.512 |

**c July 2022**

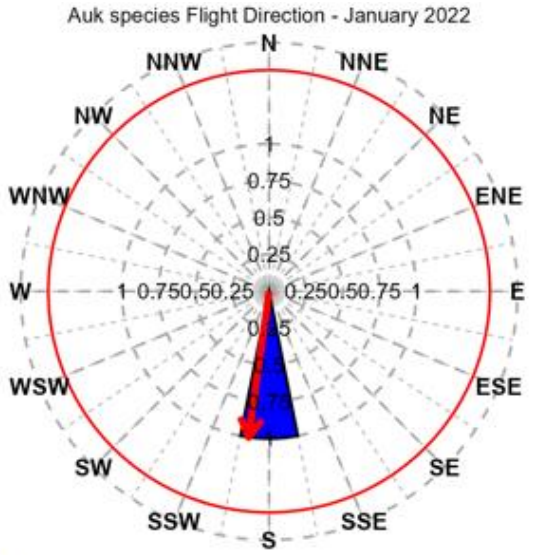
**Figure A5.452 Flight direction of puffins during the survey period**

## Unidentified auk species



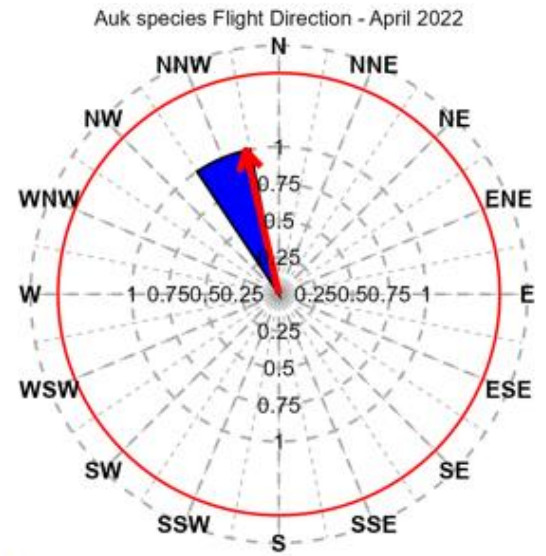

| | |
|---|---|
| Number of Observations | 1 |
| Mean Vector (μ) | 60.266 |
| Length of Mean Vector (r) | 1.000 |
| Rayleigh Test (Z) | 1.000 |
| Rayleigh Test (p) | 0.512 |

**a July 2021**



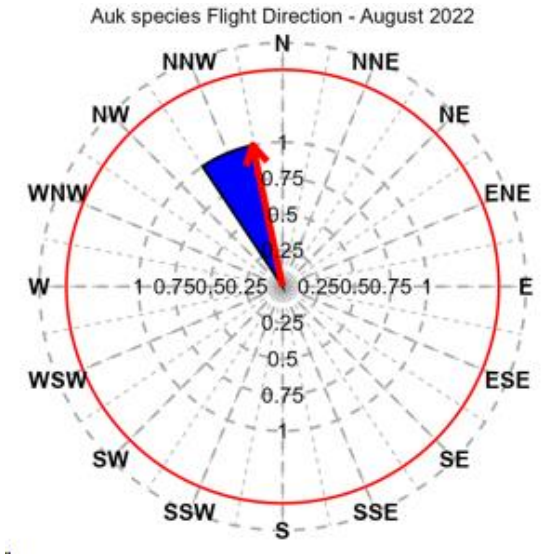

| | |
|---|---|
| Number of Observations | 1 |
| Mean Vector (μ) | 188.949 |
| Length of Mean Vector (r) | 1.000 |
| Rayleigh Test (Z) | 1.000 |
| Rayleigh Test (p) | 0.512 |

**b January 2022**




| | |
|---|---|
| Number of Observations | 1 |
| Mean Vector (μ) | 347.143 |
| Length of Mean Vector (r) | 1.000 |
| Rayleigh Test (Z) | 1.000 |
| Rayleigh Test (p) | 0.512 |

**c April 2022**

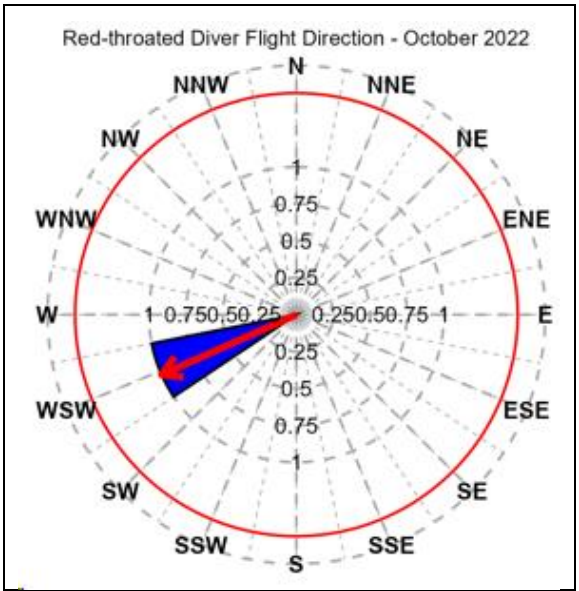



| | |
|---|---|
| Number of Observations | 1 |
| Mean Vector (μ) | 348.629 |
| Length of Mean Vector (r) | 1.000 |
| Rayleigh Test (Z) | 1.000 |
| Rayleigh Test (p) | 0.512 |

**d August 2022**

**Figure A5.453 Flight direction of auk species during the survey period**

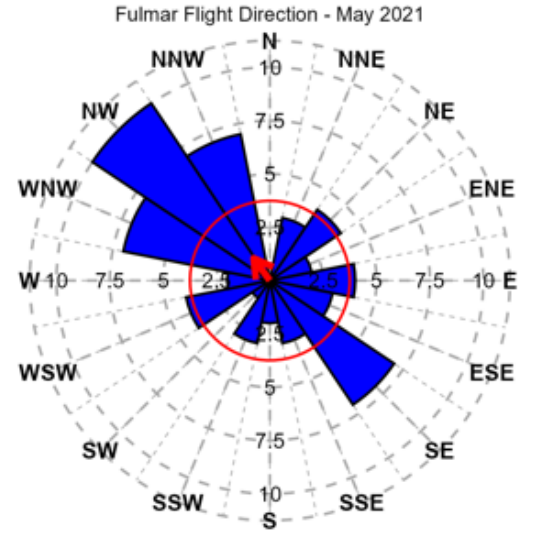
## Red-throated diver




| | |
|---|---|
| Number of Observations | 1 |
| Mean Vector (μ) | 246.841 |
| Length of Mean Vector (r) | 1.000 |
| Rayleigh Test (Z) | 1.000 |
| Rayleigh Test (p) | 0.512 |
| **October 2022** | |

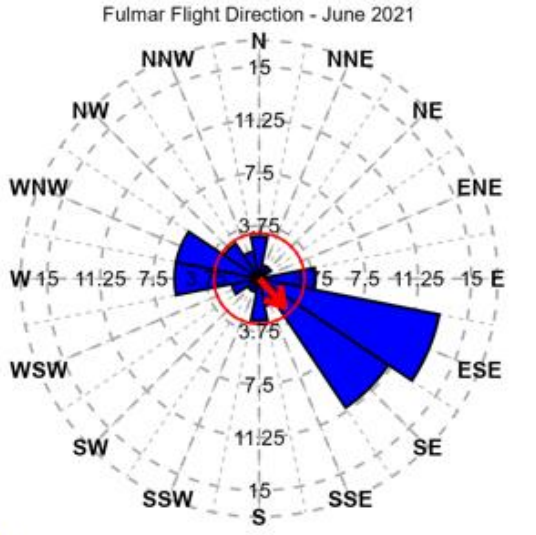
**Figure A5.454 Flight direction of red-throated divers during the survey period**

## Fulmar



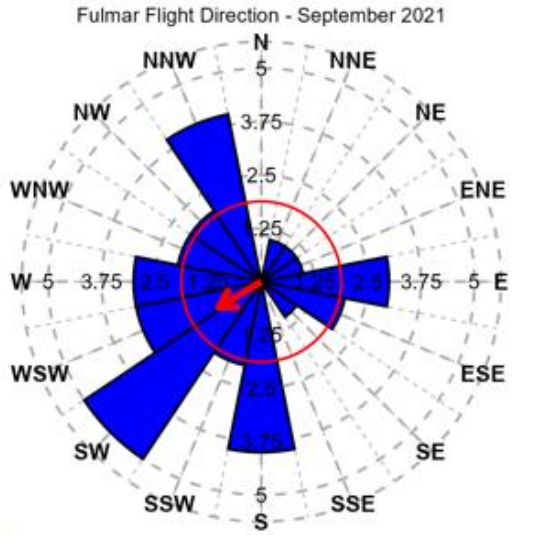

| | |
|---|---|
| Number of Observations | 62 |
| Mean Vector (μ) | 324.076 |
| Length of Mean Vector (r) | 0.129 |
| Rayleigh Test (Z) | 1.030 |
| Rayleigh Test (p) | 0.357 |

**a May 2021**




| | |
|---|---|
| Number of Observations | 59 |
| Mean Vector (μ) | 138.992 |
| Length of Mean Vector (r) | 0.205 |
| Rayleigh Test (Z) | 2.477 |
| Rayleigh Test (p) | 0.084 |

**b June 2021**



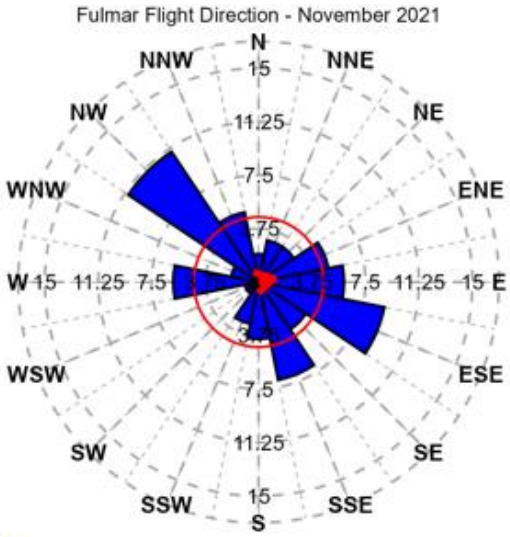

| | |
|---|---|
| Number of Observations | 34 |
| Mean Vector (μ) | 239.508 |
| Length of Mean Vector (r) | 0.233 |
| Rayleigh Test (Z) | 1.846 |
| Rayleigh Test (p) | 0.158 |

**c September 2021**



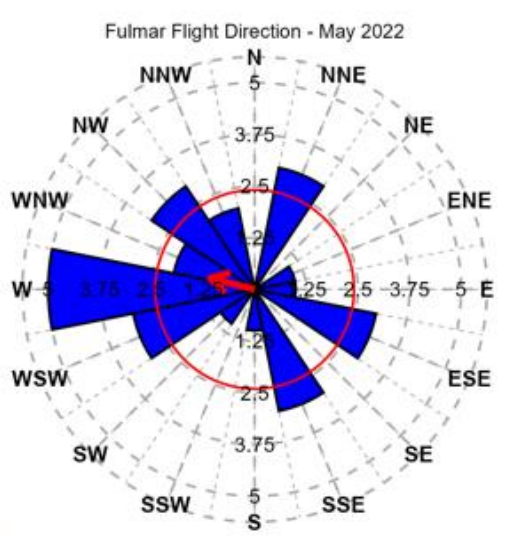

| | |
|---|---|
| Number of Observations | 2 |
| Mean Vector (μ) | 167.714 |
| Length of Mean Vector (r) | 0.855 |
| Rayleigh Test (Z) | 1.462 |
| Rayleigh Test (p) | 0.265 |

**d October 2021**



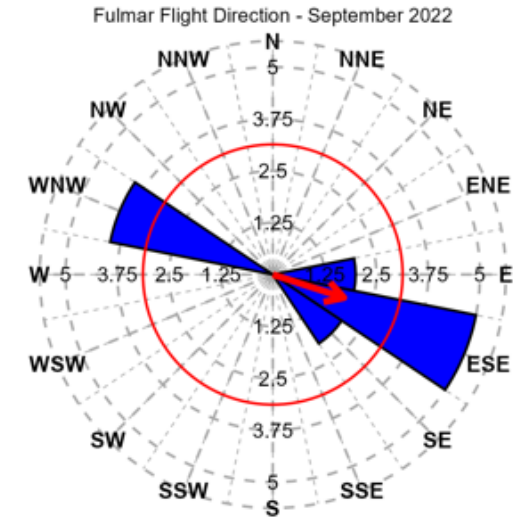

| | |
|---|---|
| Number of Observations | 72 |
| Mean Vector (μ) | 77.905 |
| Length of Mean Vector (r) | 0.100 |
| Rayleigh Test (Z) | 0.723 |
| Rayleigh Test (p) | 0.485 |

**e November 2021**



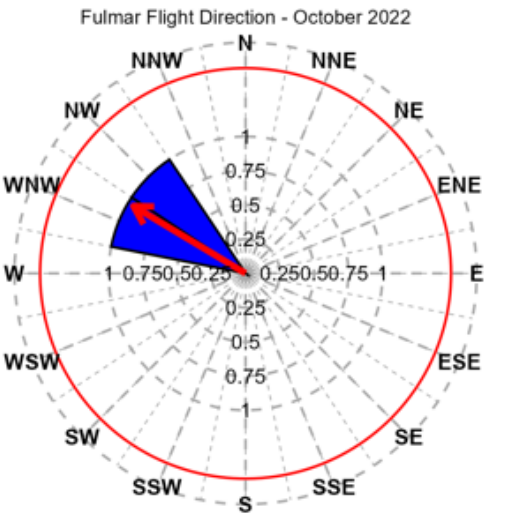

| | |
|---|---|
| Number of Observations | 28 |
| Mean Vector (μ) | 284.858 |
| Length of Mean Vector (r) | 0.221 |
| Rayleigh Test (Z) | 1.370 |
| Rayleigh Test (p) | 0.256 |

**f May 2022**




| | |
|---|---|
| Number of Observations | 13 |
| Mean Vector (μ) | 108.158 |
| Length of Mean Vector (r) | 0.361 |
| Rayleigh Test (Z) | 1.694 |
| Rayleigh Test (p) | 0.186 |

**g September 2022**

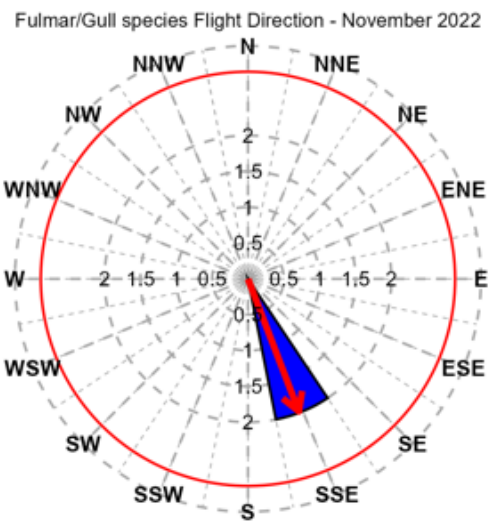


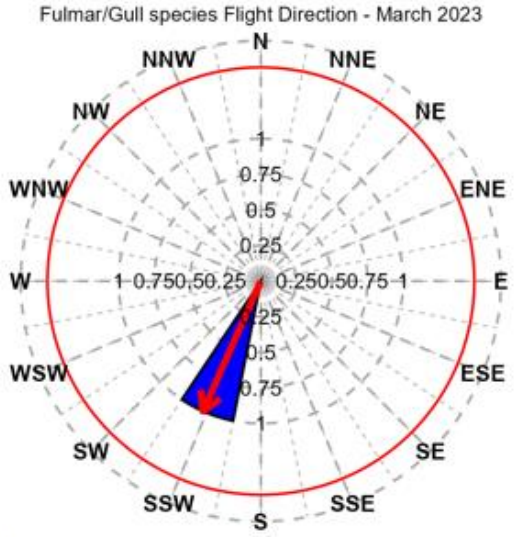

| | |
|---|---|
| Number of Observations | 2 |
| Mean Vector (μ) | 301.874 |
| Length of Mean Vector (r) | 0.954 |
| Rayleigh Test (Z) | 1.819 |
| Rayleigh Test (p) | 0.174 |

**h October 2022**

**Figure A5.455 Flight direction of fulmars during the survey period**

## Unidentified fulmar / gull species

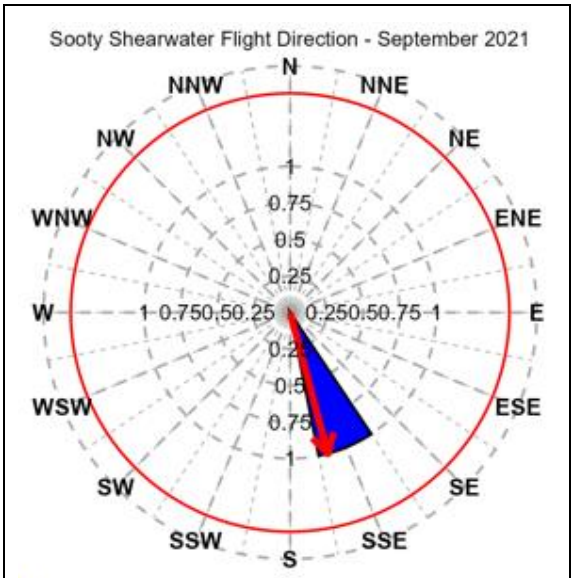



| | | | |
|---|---|---|---|
| Number of Observations | 2 | Number of Observations | 1 |
| Mean Vector (μ) | 159.288 | Mean Vector (μ) | 204.009 |
| Length of Mean Vector (r) | 0.990 | Length of Mean Vector (r) | 1.000 |
| Rayleigh Test (Z) | 1.961 | Rayleigh Test (Z) | 1.000 |
| Rayleigh Test (p) | 0.145 | Rayleigh Test (p) | 0.512 |
| **a November 2022** | | **b March 2023** | |

**Figure A5.456 Flight direction of fulmar / gull species during the survey period**

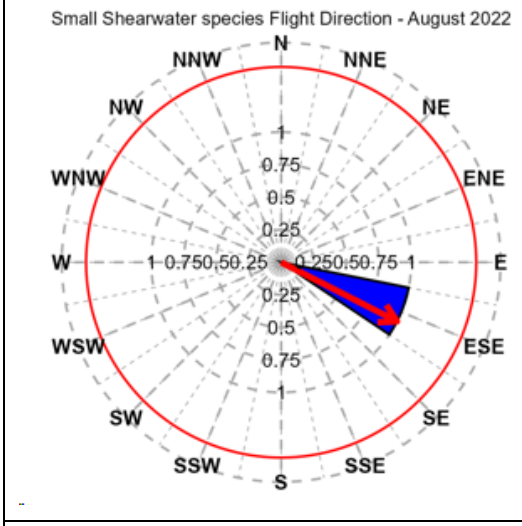
## Sooty shearwater




| | |
|---|---|
| Number of Observations | 1 |
| Mean Vector (μ) | 165.403 |
| Length of Mean Vector (r) | 1.000 |
| Rayleigh Test (Z) | 1.000 |
| Rayleigh Test (p) | 0.512 |
| **September 2021** | |

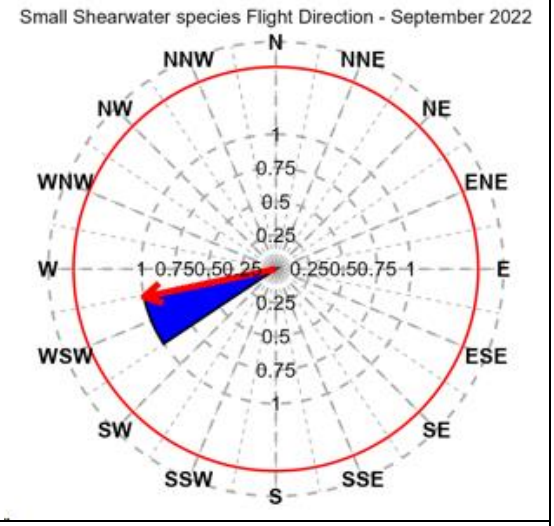
**Figure A5.457 Flight direction of sooty shearwaters during the survey period**

## Unidentified small shearwater species




| | |
|---|---|
| Number of Observations | 1 |
| Mean Vector (μ) | 117.181 |
| Length of Mean Vector (r) | 1.000 |
| Rayleigh Test (Z) | 1.000 |
| Rayleigh Test (p) | 0.512 |

**a August 2022**

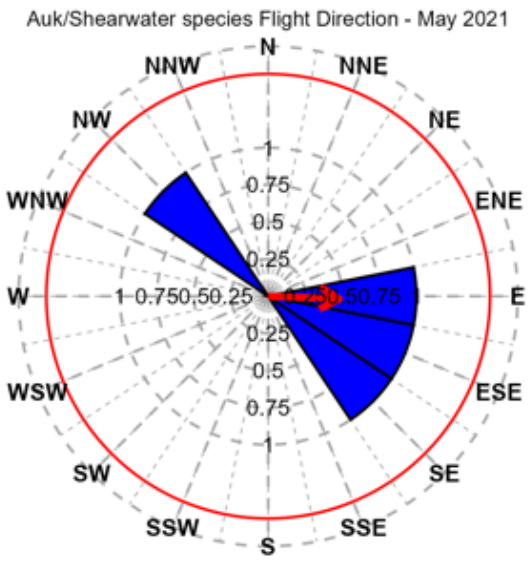



| | |
|---|---|
| Number of Observations | 1 |
| Mean Vector (μ) | 258.500 |
| Length of Mean Vector (r) | 1.000 |
| Rayleigh Test (Z) | 1.000 |
| Rayleigh Test (p) | 0.512 |

**b September 2022**

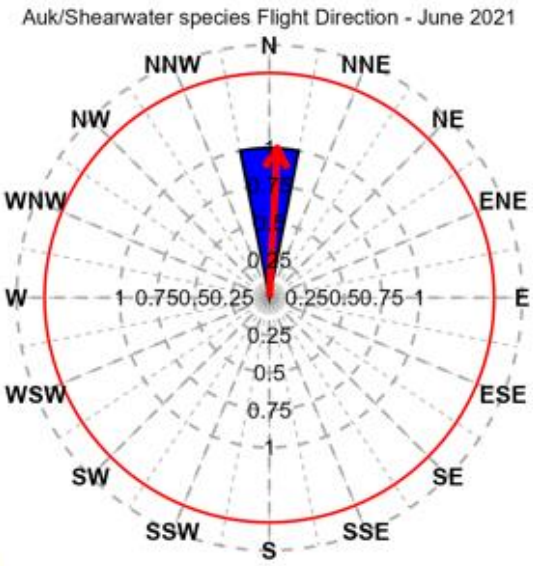
**Figure A5.458 Flight direction of small shearwater species during the survey period**

## Unidentified auk / shearwater species



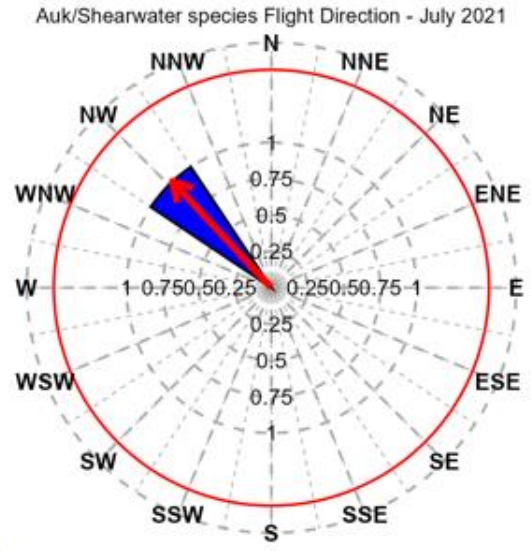

| | |
|---|---|
| Number of Observations | 4 |
| Mean Vector (μ) | 92.190 |
| Length of Mean Vector (r) | 0.478 |
| Rayleigh Test (Z) | 0.914 |
| Rayleigh Test (p) | 0.429 |

**a May 2021**



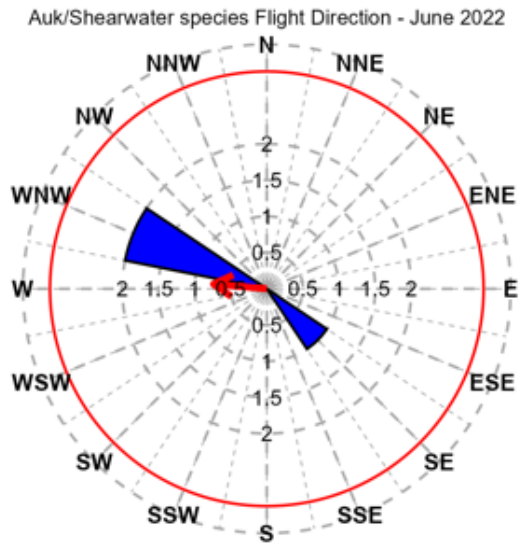

| | |
|---|---|
| Number of Observations | 1 |
| Mean Vector (μ) | 3.363 |
| Length of Mean Vector (r) | 1.000 |
| Rayleigh Test (Z) | 1.000 |
| Rayleigh Test (p) | 0.512 |

**b June 2021**




| | |
|---|---|
| Number of Observations | 1 |
| Mean Vector (μ) | 317.825 |
| Length of Mean Vector (r) | 1.000 |
| Rayleigh Test (Z) | 1.000 |
| Rayleigh Test (p) | 0.512 |

**c July 2021**

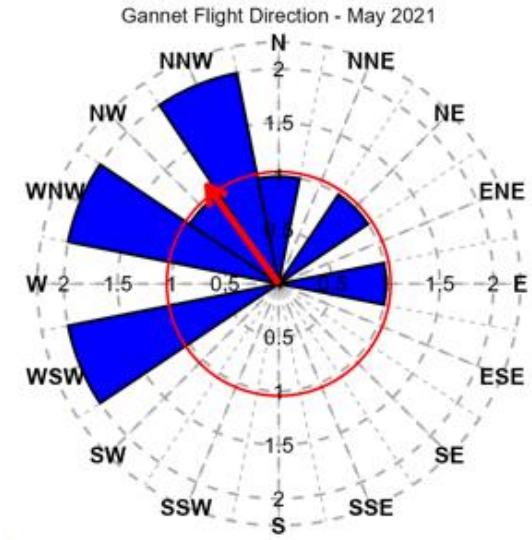



| | |
|---|---|
| Number of Observations | 3 |
| Mean Vector (μ) | 275.338 |
| Length of Mean Vector (r) | 0.369 |
| Rayleigh Test (Z) | 0.409 |
| Rayleigh Test (p) | 0.702 |

**d June 2022**

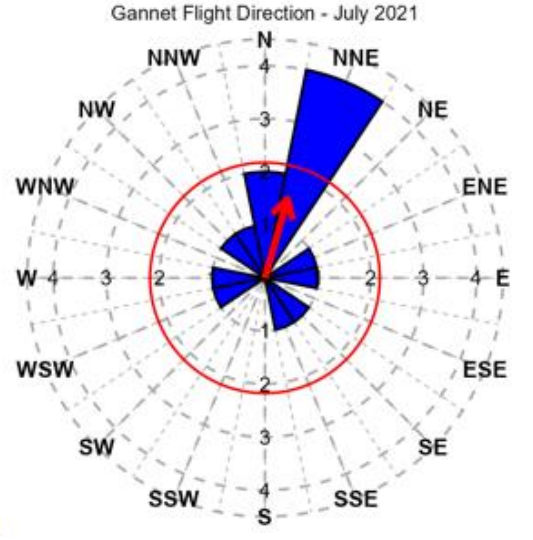
**Figure A5.459 Flight direction of auk / shearwater species during the survey period**

## Gannet



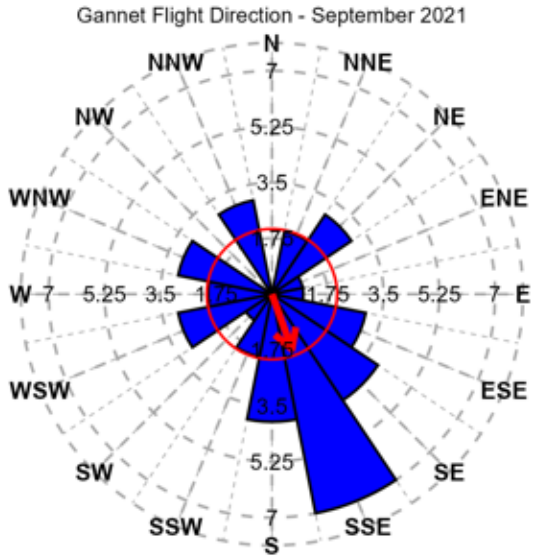

| | |
|---|---|
| Number of Observations | 10 |
| Mean Vector (μ) | 324.946 |
| Length of Mean Vector (r) | 0.564 |
| Rayleigh Test (Z) | 3.180 |
| Rayleigh Test (p) | 0.037 |

**a May 2021**



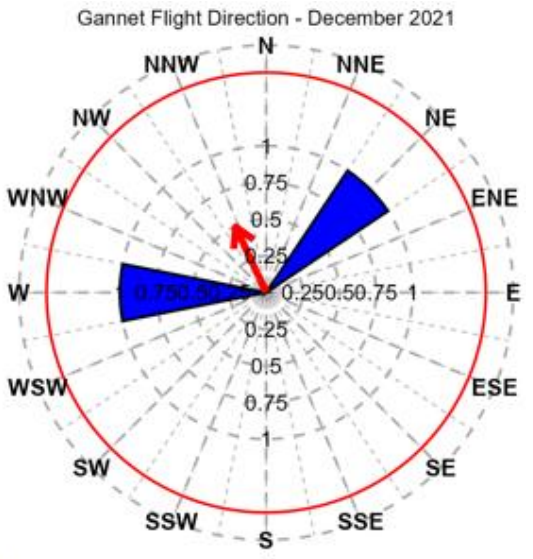

| | |
|---|---|
| Number of Observations | 14 |
| Mean Vector (μ) | 16.946 |
| Length of Mean Vector (r) | 0.386 |
| Rayleigh Test (Z) | 2.091 |
| Rayleigh Test (p) | 0.123 |

**b July 2021**



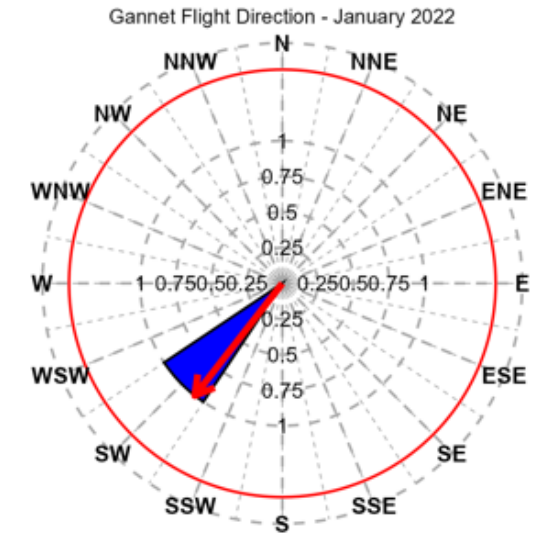

| | |
|---|---|
| Number of Observations | 39 |
| Mean Vector (μ) | 160.079 |
| Length of Mean Vector (r) | 0.261 |
| Rayleigh Test (Z) | 2.667 |
| Rayleigh Test (p) | 0.069 |

**c September 2021**



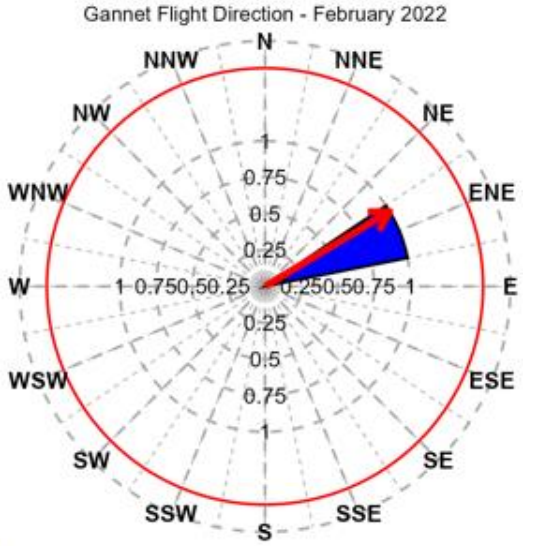

| | |
|---|---|
| Number of Observations | 2 |
| Mean Vector (μ) | 335.309 |
| Length of Mean Vector (r) | 0.493 |
| Rayleigh Test (Z) | 0.486 |
| Rayleigh Test (p) | 0.678 |

**d December 2021**



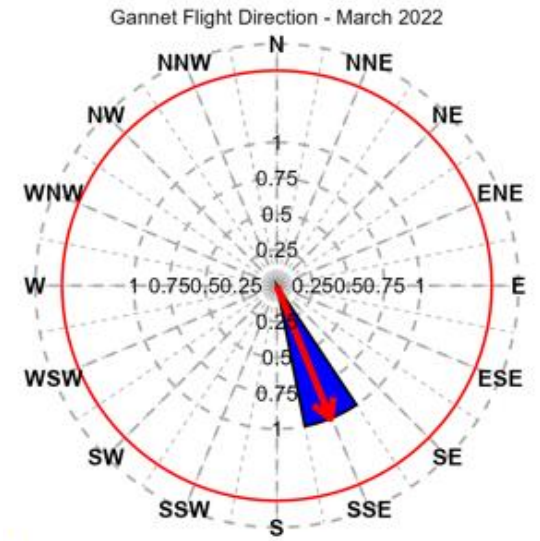

| | |
|---|---|
| Number of Observations | 1 |
| Mean Vector (μ) | 218.251 |
| Length of Mean Vector (r) | 1.000 |
| Rayleigh Test (Z) | 1.000 |
| Rayleigh Test (p) | 0.512 |

**e January 2022**



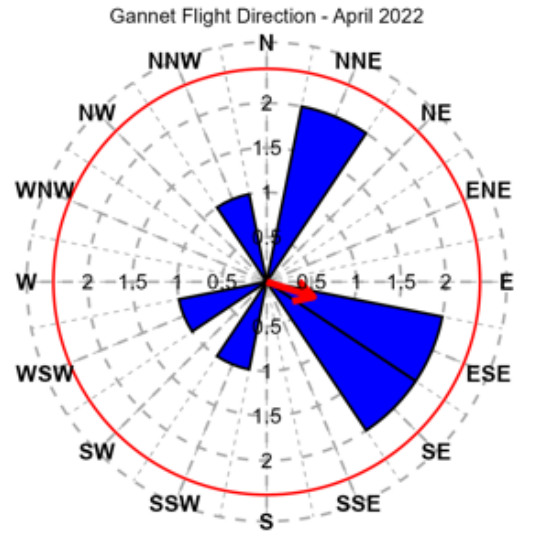

| | |
|---|---|
| Number of Observations | 1 |
| Mean Vector (μ) | 59.462 |
| Length of Mean Vector (r) | 1.000 |
| Rayleigh Test (Z) | 1.000 |
| Rayleigh Test (p) | 0.512 |

**f February 2022**



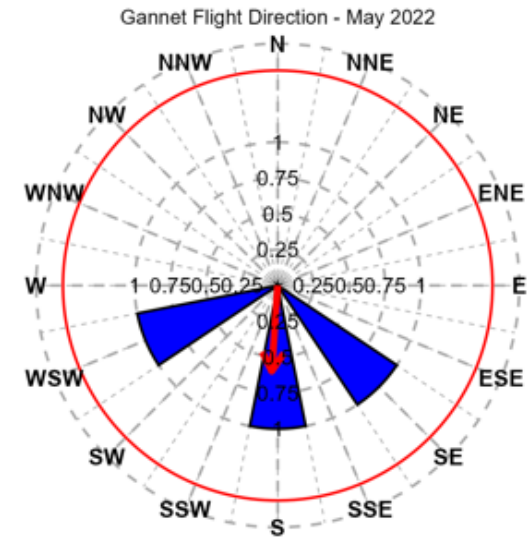

| | |
|---|---|
| Number of Observations | 1 |
| Mean Vector (μ) | 158.760 |
| Length of Mean Vector (r) | 1.000 |
| Rayleigh Test (Z) | 1.000 |
| Rayleigh Test (p) | 0.512 |

**g March 2022**



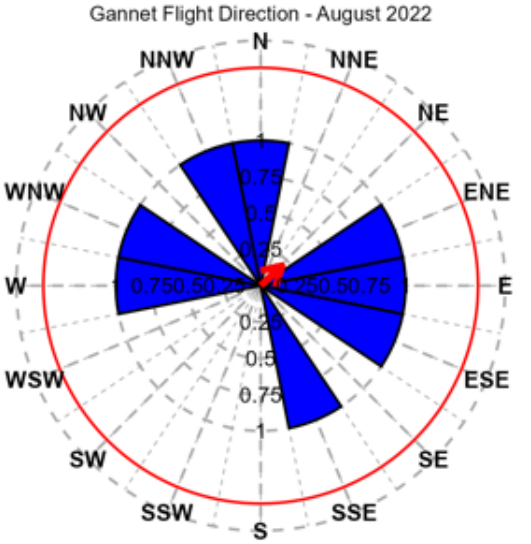

| | |
|---|---|
| Number of Observations | 9 |
| Mean Vector (μ) | 108.765 |
| Length of Mean Vector (r) | 0.274 |
| Rayleigh Test (Z) | 0.677 |
| Rayleigh Test (p) | 0.521 |

**h April 2022**



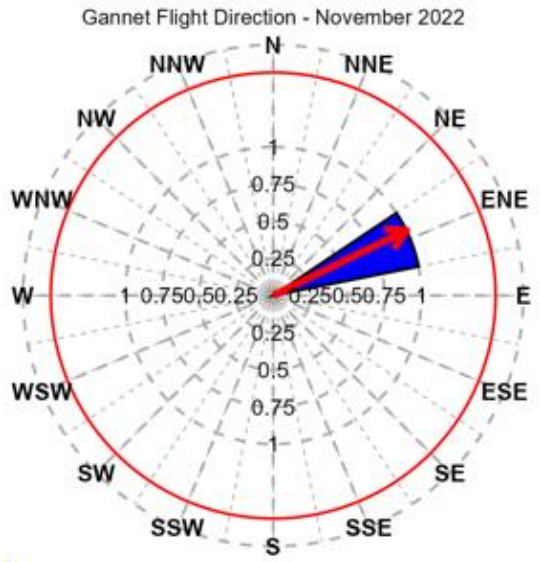

| | |
|---|---|
| Number of Observations | 3 |
| Mean Vector (μ) | 184.150 |
| Length of Mean Vector (r) | 0.599 |
| Rayleigh Test (Z) | 1.077 |
| Rayleigh Test (p) | 0.375 |

**i May 2022**



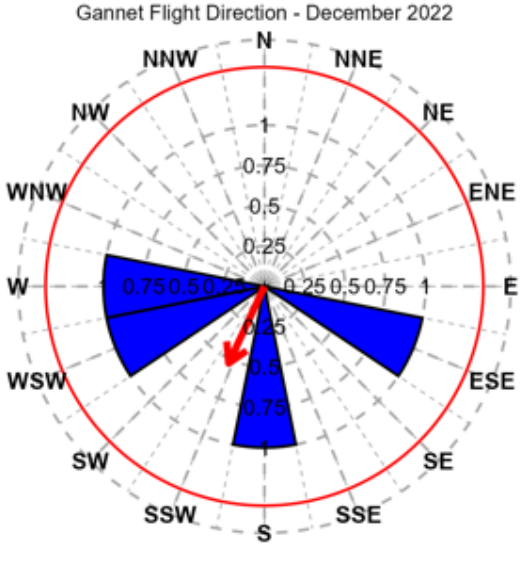

| | |
|---|---|
| Number of Observations | 8 |
| Mean Vector (μ) | 47.195 |
| Length of Mean Vector (r) | 0.201 |
| Rayleigh Test (Z) | 0.322 |
| Rayleigh Test (p) | 0.737 |

**j August 2022**



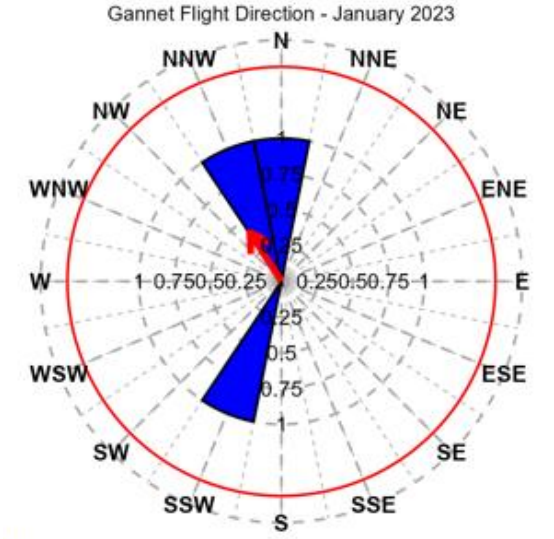

| | |
|---|---|
| Number of Observations | 1 |
| Mean Vector (μ) | 64.341 |
| Length of Mean Vector (r) | 1.000 |
| Rayleigh Test (Z) | 1.000 |
| Rayleigh Test (p) | 0.512 |

**k November 2022**



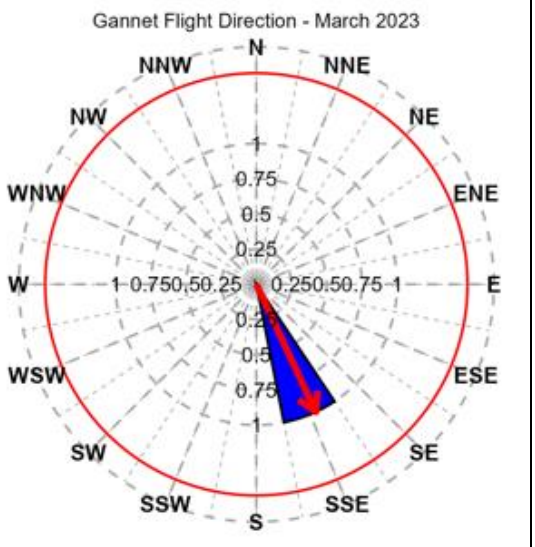

| | |
|---|---|
| Number of Observations | 4 |
| Mean Vector (μ) | 205.578 |
| Length of Mean Vector (r) | 0.526 |
| Rayleigh Test (Z) | 1.107 |
| Rayleigh Test (p) | 0.354 |

**l December 2022**



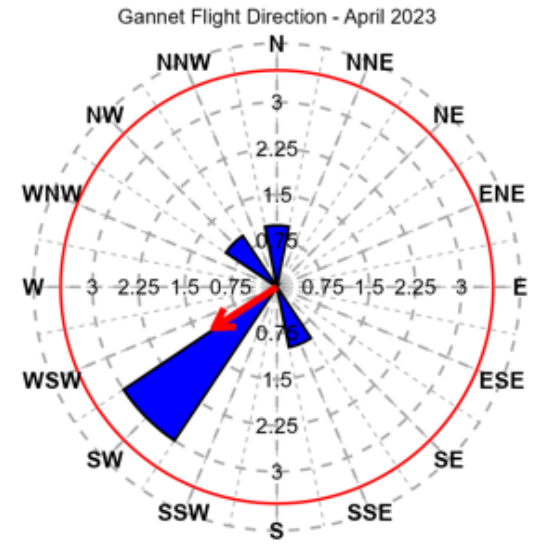

| | |
|---|---|
| Number of Observations | 3 |
| Mean Vector (μ) | 327.160 |
| Length of Mean Vector (r) | 0.407 |
| Rayleigh Test (Z) | 0.496 |
| Rayleigh Test (p) | 0.650 |

**m January 2023**




| | |
|---|---|
| Number of Observations | 1 |
| Mean Vector (μ) | 155.027 |
| Length of Mean Vector (r) | 1.000 |
| Rayleigh Test (Z) | 1.000 |
| Rayleigh Test (p) | 0.512 |

**n March 2023**

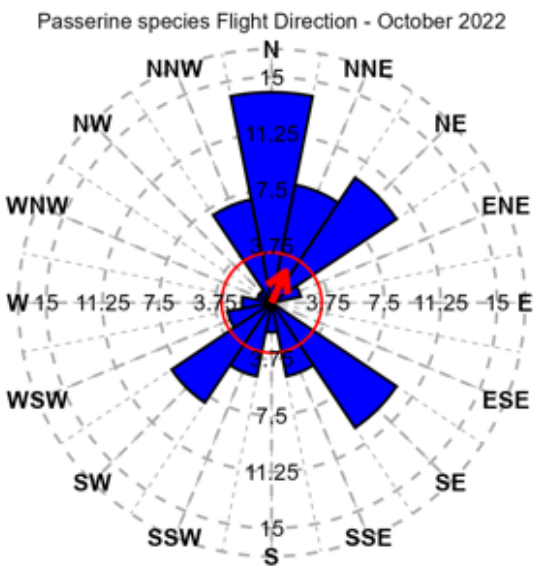



| | |
|---|---|
| Number of Observations | 6 |
| Mean Vector (μ) | 237.237 |
| Length of Mean Vector (r) | 0.407 |
| Rayleigh Test (Z) | 0.992 |
| Rayleigh Test (p) | 0.388 |

**o April 2023**

**Figure A5.460 Flight direction of gannets during the survey period**

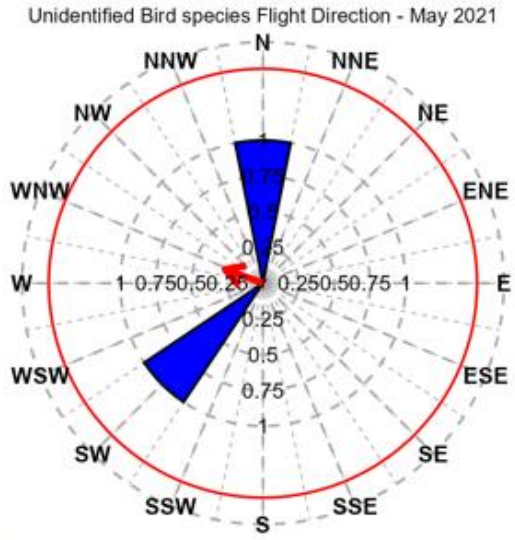
## Unidentified passerine species




| | |
|---|---|
| Number of Observations | 78 |
| Mean Vector (μ) | 24.499 |
| Length of Mean Vector (r) | 0.161 |
| Rayleigh Test (Z) | 2.017 |
| Rayleigh Test (p) | 0.133 |
| **October 2022** | |

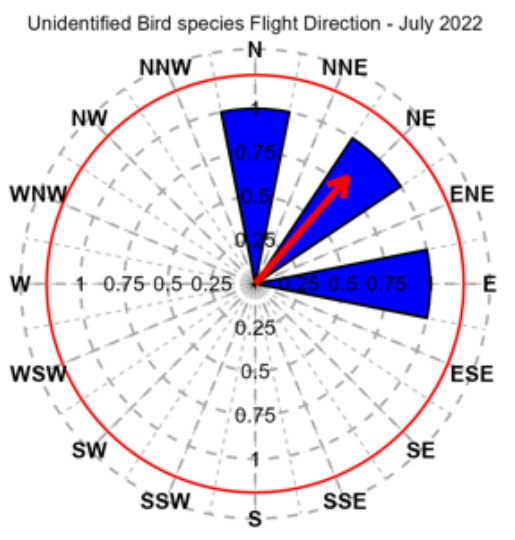
**Figure A5.461 Flight direction of passerine species during the survey period**

## Unidentified bird species



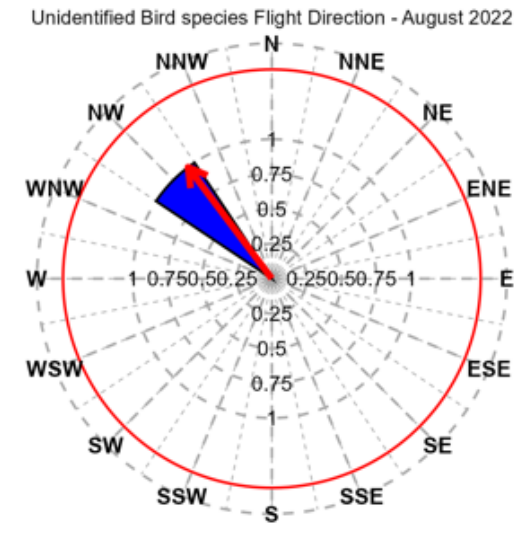

| | |
|---|---|
| Number of Observations | 2 |
| Mean Vector (μ) | 290.667 |
| Length of Mean Vector (r) | 0.283 |
| Rayleigh Test (Z) | 0.160 |
| Rayleigh Test (p) | 0.883 |

**a May 2021**



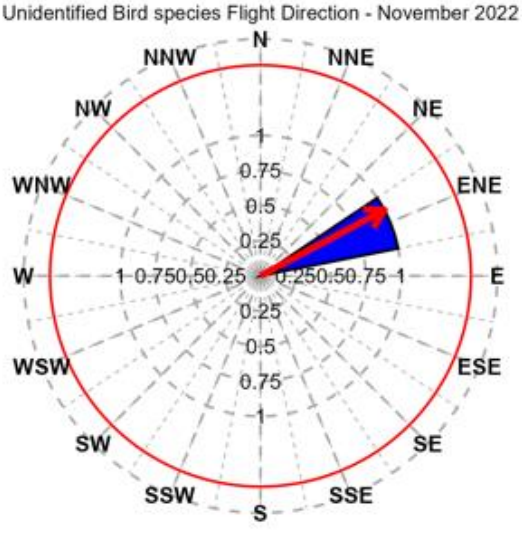

| | |
|---|---|
| Number of Observations | 3 |
| Mean Vector (μ) | 41.215 |
| Length of Mean Vector (r) | 0.800 |
| Rayleigh Test (Z) | 1.919 |
| Rayleigh Test (p) | 0.150 |

**b July 2022**




| | |
|---|---|
| Number of Observations | 1 |
| Mean Vector (μ) | 323.890 |
| Length of Mean Vector (r) | 1.000 |
| Rayleigh Test (Z) | 1.000 |
| Rayleigh Test (p) | 0.512 |

**c August 2022**




| | |
|---|---|
| Number of Observations | 1 |
| Mean Vector (μ) | 62.902 |
| Length of Mean Vector (r) | 1.000 |
| Rayleigh Test (Z) | 1.000 |
| Rayleigh Test (p) | 0.512 |

**d November 2022**

**Figure A5.462 Flight direction of bird species during the survey period**

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